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COLONIAL DEVELOPMENT: MAN-POWER AND FINANCE

WHEN the consultative committee for Co-operative Economic Development in South and South-East Asia met recently in New Delhi, it was able to note indications of considerable progress under the Colombo Plan during 1952–53, especially in agriculture, irrigation, power and transport. Resources being devoted to development projects, whether under the Colombo Plan or in the development programmes of countries in South and South-East Asia, have progressively increased since 1951, although many of the projects are of long-term character and their full benefits will not accrue for several years. In Ceylon about 20,000 further acres of irrigable land were opened during 1952–53, mainly under the Gal Oya scheme. The improvement of Colombo harbour is well under way, and completion of the first stage of the hydroelectric scheme at Norton Bridge gave an increase in capacity of 25 MW. In India, irrigation works benefited three and a half million acres of land in 1952–53, while some 510,000 acres were reclaimed by the Central Tractor Organization. These and other measures and good seasons contributed to give an increase in food production of nearly five million tons on the previous year. Power generation capacity was increased by 315 MW., and satisfactory progress made with a number of major water-control projects. Satisfactory progress was reported in various multi-purpose and irrigation projects in Pakistan; the Lower Sind Barrage reached an advanced stage and its total installed capacity was increased from 70 MW. to 140 MW.

In the Federation of Malaya, the first stage of the Connaught Bridge power station was completed, the gap in the East Coast Railway was closed by re-laying 200 miles of line, and in Singapore a new power station with an interim capacity of 40 MW. came into operation. Progress with development in roads, air transport and tele-communications in Sarawak was reported, while schemes for irrigation, communications, electricity and housing were under way in North Borneo. In Nepal, a systematic geological survey is under way, five more important districts have been linked by air services and the construction of 79 miles of motor road to connect Kathmandu and Bhaise was started in September 1952.

The Technical Co-operation Scheme of the Colombo Plan, it should be recalled, was started in May 1950 by seven members of the British Commonwealth—Great Britain, Australia, Canada, Ceylon, India, New Zealand and Pakistan—to provide technical assistance to the countries of South and South-East Asia to the value of £8 million up to the middle of 1953. Membership has now risen to twelve, with the inclusion of Cambodia and Vietnam, Burma, Nepal and Indonesia, while the Philippines and Thailand, though not members, have received assistance. The scheme is on a smaller scale and different principles from the United Nations Expanded Programme of Technical Assistance, assistance being given by one country to another, and the cost is

deducted from the donor country's contribution. Expenditure, moreover, is not tied to an annual budget: in the first eighteen months, up to December 1951, only £400,000 was spent, and the period of operations was consequently extended to seven years, without inviting further contributions. By December 1952 expenditure totalled £1·3 million.

Most of the money has been spent on the supply of experts and on places for trainees. Twice as many experts (90) were provided in 1952 as in the first eighteen months of the scheme, and 538 places for trainees, compared with 309 in the earlier period. While the scheme is not intended to be a source of capital assistance, capital equipment can be provided for training and research purposes and for use by experts; but up to the end of 1952, only £33,000 had gone to the supply of equipment in this way, although requests amounting to another million pounds were under consideration. Further, the Colombo Plan is intended not to meet all the needs of South and South-East Asia, but rather to fill gaps left by other similar organizations. Most of the experts have, in fact, been provided by other organizations, the scheme under the Colombo Plan concentrating on the supply of places for trainees. Thus up to December 1952 under the United Nations Technical Assistance Programme, 568 experts and facilities for 564 trainees had been provided for the Colombo Plan countries, while the United States had provided a further 210 experts and 403 trainees.

The operation of both the Colombo Plan Technical Co-operation Scheme and of the United Nations Expanded Programme of Technical Assistance has recently been reviewed by Political and Economic Planning in a broadsheet "Technical Aid after Three Years" (No. 356. October 26, 1953). This valuable broadsheet is based on examination of current reports of both programmes (Fifth Report of the Technical Assistance Board to the Technical Assistance Committee, United Nations. June 1953. The Colombo Plan Technical Co-operation Scheme: Report for 1952 by the Council for Technical Co-operation in South and South-East Asia. February 1953. H.M.S.O.). The examination not only brings out the common features and experiences of the two schemes: it also indicates common difficulties and ways in which one scheme could benefit from the experience of the other.

One feature that stands out from this comparison is that both programmes considerably over-estimated the speed with which the Asian countries could profitably utilize the services of foreign experts. The proviso in the Colombo Plan which enables unspent balances to be reserved for future use has kept the scheme free from the temptation that besets agencies under the United Nations scheme, where unspent sums are forfeit at the end of the year, to unload funds and experts too rapidly, even to the point of slender returns, inordinate waste and the generation of friction. None the less, it is clear that, if development is to be soundly based, methods must be found of training locally an adequate number of technicians at all levels. Member countries are accordingly encouraged to employ experts who will stay in the host country for some time and combine instruction of trainees with other duties. This, for the reason just given, is easier under the Colombo Plan than under the United Nations scheme as at present constituted, and assistance given under the former has been increasingly directed to the provision of equipment for local training institutions of every kind. Tool-room equipment has been provided, for example, for an engineering college in India, together with a foreman to demonstrate its use; equipment is being provided for six technical high schools in Pakistan and for about fifty secondary schools in Ceylon.

Commitments to provide equipment in this way now amount to about £750,000; and Ceylon, India and Pakistan have also undertaken to provide assistance to other countries in the region. Here again they are tending to use their funds for the provision or strengthening of training institutions, and each of them is creating in its own country specialized training facilities which will be available to trainees from other parts of the region. The P E P broadsheet suggests that activities under the Technical Co-operation Scheme may be directed increasingly to the development of training institutions.

That the scheme may have a special contribution to make in this field may well be true, just as it is that the great need in Asia is to train Asian experts, and that this is best done in the Asian countries themselves. This may involve, as the broadsheet suggests, some re-adjustment in accepted methods of work, of the use of experts and of fellowship programmes, especially under the Expanded Programme of the United Nations. Fundamentally, it is a problem of education, not merely of technical training but also of training teachers, Civil servants of all grades, and local leadership generally. The implications of this situation are far from confined to Asia. They bear closely on what is taking place to-day in Africa and elsewhere also—in the Rhodesias, in Nigeria, in the West Indies and in British Guiana. It is only against the background of the political situation in such countries that the real importance of this educational work under the Colombo Plan and the United Nations Expanded Programme of Technical Assistance can be appreciated, or the recommendations of the Carr–Saunders Commission for a Central African University or the findings of the two Missions that visited African Colonies in 1951 to study problems of education on behalf of the Nuffield Trust and of the Colonial Office.

The importance of this technical assistance programme and especially of this factor of educational development is brought out very clearly in the recently issued report of the Mission of United Kingdom industrialists to the West Indies in October–November 1952 (Industrial Development in Jamaica, Trinidad, Barbados, and British Guiana. Colonial No. 294. H.M.S.O. 1953. 2*s*. net). The Mission estimates that the volume of industrial development, with the range and scope of which it was impressed and satisfied as to its sound basis, would be doubled within the next ten years, provided no unexpected

and untoward political developments occurred. Nevertheless, it recognizes that, apart from agricultural products, the growth of industrial development in these territories depends mainly upon an increase in internal consumption. In the main, increased purchasing power must come from an expansion of agricultural production. While the latter expansion is regarded as feasible, the doubling of industrial production will involve the investment of very large sums. For Jamaica alone this is put at not less than fifty million pounds of new money over the next ten years. Such sums cannot be found from local sources, and the Mission rightly stresses the importance of a suitable climate for investment in order to attract outside investors to the territories.

Even if the outside capital can be attracted to assist the more promising lines of development in agricultural processing, building materials, the engineering industries and the chemical and allied industry, for which the Mission makes specific suggestions, there is still a major difficulty. Not only has government policy hitherto tended to give excessive protection to the least efficient producer, but also the general standard of efficiency is low. This is due partly to the low standard of technical training and to the difficulties in obtaining efficient foremen. Moreover, insularity tends to discourage the introduction from outside of technicians, foremen or managers—although without an adequate supply of suitable supervisors, charge-hands and foremen, satisfactorily trained and capable of accepting responsibility, industrial development will be handicapped if not frustrated.

The Mission makes a number of suggestions for improving the facilities for technical training; but it has no hesitation in condemning as misguided the difficulties placed by some immigration authorities in the way of recruitment of technicians and managers from overseas to meet the dearth of supervisors and managers as well as foremen. No hope is held out that industrial expansion by itself will solve the population problem in the crowded territories. It can make a valuable contribution to easing the problem if it is not impeded by insularity, political instability or other like factors making for inefficiency and the protection of the less efficient. Success, in fact, depends on generating the same goodwill, mutual understanding and effective co-operation as are the basis of the success of technical co-operation under the Colombo Plan, the Expanded Programme of the United Nations and the United States programme associated with the well-known 'Point Four'.

What needs to be emphasized is, in fact, the way this whole question of Colonial development and technical assistance to the under-developed areas of the world is interlocked. No single area can be considered in isolation: advance or recession may have repercussions that are incalculable in other areas. That is why, for example, it is so important that the British Government should handle the question of a university for Central Africa with vision, imagination and statesmanship. It is not a matter which affects Rhodesia or Central Africa alone. The effects on the whole of Africa and on the relations between the more advanced and the more backward peoples throughout the world can be far-reaching. The Carr–Saunders Commission (see *Nature*, July 4, p. 1) was obviously fully aware of all these implications. In its brief glance at technical education, it noted that technical training of Africans to a higher standard than that of the trades school scarcely existed in any of the three territories with which the Commission was particularly concerned, although there was great scope for technically trained Africans, particularly in the government service. Wisely, the Commission decided that the development of such training would best be left for the next five to ten years to existing and additional development schemes and centres, in the belief that in the meantime an improvement in general education would provide a firmer basis for the development of technical education.

It will also be recalled that doubts were expressed by Dr. Alexander Kerr, in his note of reservation, as to whether, in a university sponsored by Europeans, the practice of inter-racialism would be allowed to proceed to the point where the numbers of the respective races would approximate to equality, and still less to the stage where the African element would exceed the European. The racial situation has been another factor in the technical training of Africans. These considerations alone make it clear that the British Government should give a decisive lead, although the Commission reported in the first instance to the Central African Council. The offer of £1¼ million from Colonial Development and Welfare Funds (*Nature*, October 10, p. 654) is a step in the right direction. A generous response to the challenge of the report by providing not merely the capital to launch the project but also an assured and adequate endowment during the early years would go far to encourage private benefactions, such as Sir Ralph Furse's offer to endow a scholarship at the proposed Central African University and the Central African Round Table's effort to raise funds to endow a chair of race relations, political philosophy and allied subjects.

A further improvement in the general position was indicated by a written answer given by Mr. H. A. Nutting, Parliamentary Under-Secretary of State in the Foreign Office, in the House of Commons on November 11, that the Government proposes to contribute £600,000 in 1954 to the U.N. Expanded Technical Assistance Programme and is prepared to increase this by a further £50,000 if the total pledged by all countries (including the United Kingdom) exceeds 25 million dollars. An advance payment of £150,000 early in January is proposed. The condition has since been withdrawn.

The British contribution to the Expanded Programme for 1953 was reduced from £1,400,168 on the grounds that the previous allocation had not all been spent. It should be remembered in fairness that out of the original total of £22,388,413 only France, with £1,207,500, and the United States, with £12,767,145, exceeded £1 million; no other country apart from the U.S.S.R. (£1 million) and Canada (£800,000) promised to contribute more than half a

million pounds. But when the present approved programme for 1953, after the twenty per cent cut, is fully implemented, the Technical Assistance Board and the participating organizations will not have available more than the three million dollars now constituting the Special Reserve Fund—an amount which will be scarcely sufficient to finance operations during the first six weeks of the present year, pending the receipt of substantial contributions which may be pledged for 1954.

With no balance to carry over and the funds available for 1954 as yet unknown, the financing of the projected 1954 programme, mainly consisting of projects already in hand or started in 1953, is, to say the least, precarious. If no more is pledged than in 1953, the programme will have to be cut by twenty per cent, with less not only of capital already invested by the United Nations, but also of the corresponding investments made by governments receiving aid. It is difficult to justify parsimony in this field, even if in earlier years mistakes have been made in undertaking badly prepared projects with unsuitable men.

These lessons are being learned, and though ninety-seven countries were assisted in 1952, as against seventy-one in the previous year, usually with expanded programmes, and 2,529 experts were currently employed compared with 797 at the end of 1951, and the number of fellowships rose from 845 to 2,127, something has already been done to improve the administration of the Expanded Programme and reduce the excessive travel and frustration of experts, in which respects the Programme had compared unfavourably with that of the Colombo Plan. Such spending and waste is, as already noted, encouraged by the present financial arrangements, with their absence of carry-over and continuity; but the increase in reciprocal aid between the under-developed countries as well as the increased demand for the services of the United Nations scheme have done something to encourage the development of new and improved methods of working.

Technical assistance has become a method of helping the poorer countries to carry out their own development plans, and requests now far exceed the resources available to the agencies. In these new circumstances the hitherto accepted methods of work under the United Nations scheme may sometimes be as much a hindrance as a help. The training of local people to Western standards of education may not, as *Planning* points out, be the most appropriate way of raising the general level of the community. The loss of key men for training under a fellowship programme may be a serious matter for local administrations, which can ill afford to spare them even for a short time.

The use of experts for initiating and advising on schemes may be essential; but their most valuable contribution is in adapting themselves and applying their knowledge to the conditions in which they are working. Here again the best results are likely to be obtained with experts who are prepared to stay for longer periods—another argument for reasonable continuity in the financial arrangements. When, however, the further improvements in administration and in the organization of regional centres, which *Planning* visualizes as possible, have been effected, the two main problems of adequate funds and of sufficient assurance of continuity will remain. Without them neither efficient working nor the benefit of the investment already made can be secured. Apart from considerations of wise economy and of the importance of the under-developed areas as potential future markets, the past year has dealt sufficient shocks—sometimes undeserved—to confidence in Britain's sincerity; it would be unwise to neglect any means that promise to strengthen or re-establish such confidence, particularly among the Colonial peoples.

SWEDISH SCIENCE SINCE 1650

Swedish Men of Science, 1650–1950

Edited and with an Introduction by Prof. Sten Lindroth. Translated from the Swedish by Burnett Anderson. Pp. 296. (Stockholm: Almquist and Wiksell, 1952.) n.p.

THIS work is a translation by Burnett Anderson from the Swedish original, but it is so well done that the reader is seldom conscious of the fact. In a preliminary essay the editor, Prof. Sten Lindroth, traces the introduction of learning and the development of science in Sweden from its early beginnings right up to the present day, against its social, political and religious background. Barbarism, he writes, or the absence of any specific culture, persisted rather longer in Scandinavia than in the more southerly European countries. The first contacts between Sweden and the educated communities of the rest of Europe followed the introduction of Christianity in the eleventh century, but the absorption of wisdom from the outer world was at first slow, and confined to clerical circles. However, a university was founded at Uppsala as early as 1477, and, very soon after, the art of printing was introduced into the country. A set-back occurred during the sixteenth century, resulting from political and religious disturbances, the latter connected with the introduction of Evangelical Lutheran doctrines into Sweden. The University of Uppsala was closed during most of this century, in which, significantly, the only Swede to become internationally known was the exiled Catholic Archbishop Olaus Magnus. His famous account of the natural history and peoples of Scandinavia, "Historia de Gentibus Septentrionalibus", was published in Rome in 1555. Conditions became more favourable for the advancement of learning during the seventeenth century, when new universities were founded at Dorpat, Åbo and Lund.

Cartesian ideas were first discussed in Sweden at least as early as 1660, and, with their introduction, the old scholastic thinking and Aristotelianism died out, though not without a struggle. Thenceforward the development of the sciences in Sweden took place on lines very similar to those followed in other European countries. A Swedish Academy of Science was founded in 1739, and after this, during the eighteenth century, there was an active interchange of ideas between Swedish scientific workers and those of other countries, promoted by scientific publications, by correspondence and by travel.

In the thirty essays that follow Prof. Lindroth's introductory remarks, the lives and achievements of Sweden's most outstanding men of science are described by a number of authors. The first to receive mention is Olaus Rudbeck (1630–1702), discoverer of the lymphatic system. Among the names that follow, some, such as those of Swedenborg, Carl von Linné, Celsius, Wilcke, Scheele and Svante Arrhenius, are more familiar than others. Nor is it surprising that, in the country that gave birth to von Linné, botanists and biologists are to the fore, but other sciences are well represented. The strong school of chemistry, mineralogy and geology that flourished in Sweden in the eighteenth century is represented by Swedenborg, Wallerius, Cronstedt, Bergman and Berzelius. This school perhaps owed its origin to the prominence of metalliferous mining in Sweden. Indeed, it is stated that chemical research was carried out in the laboratories of the Board of Mines before 1700, and it would be interesting to hear more of this activity. Two of the later essays describe the work of Sweden's famous explorers Nordenskiöld and Sven Hedin, and the concluding one gives an account of the work of Manne Siegbahn, Nobel laureate in physics. Jointly the several authors present an overall picture of scientific activity in Sweden for the past three hundred years of which she may well be proud.

The sources from which these essays have been compiled, apart from personal contacts, are listed in a bibliography, and many of the references are to articles in Swedish. British and American readers can therefore count themselves fortunate in having this very interesting compilation made available to them in an excellent translation. The accounts of individual men of science are not merely catalogues of work done, but also contain much of human interest. The book should appeal to all scientific workers, not merely to those having a professional interest in the history of science.

LAMARCKISM

Trends of Life

By Prof. F. Wood Jones. Pp. 191. (London : Edward Arnold and Co., 1953.) 10*s*. 6*d*. net.

A FAIR proportion, perhaps a majority, of young zoologists begin their studies with a warmly sympathetic attitude towards what has come to be called, no matter how inappropriately, the doctrine of the inheritance of acquired characters. It is intelligible and forthright ; in ignorance of genetics, an alternative is difficult to propound ; and a certain deep-seated sense of the fitness of things is gratified by the belief that an animal's own activities, accomplishments and endeavours should contribute to the heritage of its progeny. But as time goes on, the student learns that the hereditary system which provides for genetic continuity is not, after all, as malleable as Lamarckian theory obliges him to believe. It is, on the contrary, a system of quite extraordinary stability. The stability is by no means absolute, but departures from it are of a special kind—rare, abrupt and discontinuous ; they do not arise in response to an organism's needs, nor do they, except by accident, gratify them. The importance of these departures from stability is that the almost infinitely close-woven texture of genetical variation takes origin from them. The Mendelian system of inheritance is of such a kind as to keep this genetical diversity permanently in being and randomly stirred about. But living populations do not usually remain in this vacillating state, for prolonged systematic changes of their genetical composition may often be superimposed upon it. When these changes have reached a certain not wholly arbitrary magnitude, they are described as 'evolutionary'. There is evidence that natural selection is an instrument by means of which genetical transformations of evolutionary stature have been brought about. There is at present no evidence whatsoever that any other agency is of comparable pervasiveness and power.

To these propositions, right or wrong, sufficient or incomplete, Prof. F. Wood Jones remains impenetrably deaf. His present work makes no claim to originality ; and when we read yet once again that physical and chemical analyses can give us evidence only of "dead protoplasm" ; that parallelism in evolution, and the occurrence of transient adaptations peculiar to embryos, are in some way highly discreditable to Darwinism, and the "astronomical" mortality of pollen grains quite fatal to it ; that domestication is, after all, only "a condition under which viable pathological forms and generally abnormal types may survive and become perpetuated by artificial conditions" ; that natural selection is a "blind outside agency" that leaves evolution to the mercy of chance ; when, in short, we realize that not one *bêtise* of traditional Lamarckism is to be spared us—then indeed it is hard to disallow his claim. It is my opinion that Prof. Wood Jones does not understand the genetical theory of selection. There is certainly no internal evidence that he does, for he expounds it nowhere. How otherwise can we account for the omission of the name of Mendel ; for such a blunder as the equation of 'organic' or imitative selection with Lamarckism ; and for the complete misrepresentation of—to take only one example—A. J. Cain's appeal that we should be cautious in speaking of 'non-adaptive' characters ? The tragedy is that Lamarckism can be, and should be, expounded as a serious scientific theory. Prof. Wood Jones's book has therefore done it, in my opinion, a very grave disservice.

It should not need saying that Prof. Wood Jones is a vitalist ; but on this score there is less reason to find fault. For the 'ghost in the machine' has, it appears, been sent packing ; and all that in the end we are now to understand by vitalism is this : that "the distinction of living matter is its power of self-maintenance which is manifested in activities that are characteristically directive". This is an unobjectionable doctrine ; what one may wonder at is that vitalism should have the temerity to claim its proprietary rights. Its weakness, of course, is that it is only a description of, or comment on, the ordering of natural processes : it is the starting-point of analytical investigation, that very state of affairs which causal analysis sets itself to unravel and expound. But if a reconsideration of vitalism has at long last led Prof. Wood Jones through tortuous pathways to formulate that principle which animates the science of analytic physiology, then all parties should be satisfied, and perhaps—but it is too much to hope for—the matter might be allowed to drop.

Prof. Wood Jones claims to have expounded his views "without any sort of criticism of the opinions held by others", but the briefest perusal of his book will prove the claim ill-founded. Sherrington (of all people !) is rapped over the knuckles for failing to

realize that the several metabolic processes of the cell must be co-ordinated if life is to be maintained; Darwin is made to appear an ignorant dogmatist; and a footnote irrelevant to the prevailing argument contains an attack upon a distinguished zoologist for a blunder corrected a quarter of a century ago. But Prof. Wood Jones's censure is by no means confined to individuals: it embraces the whole of civilized mankind. Not one virtue illuminates man's degradation. Man ("arch-destroyer of life") is the slave of his so-called civilization, and his slavery is "the degenerative bondage of the dependent domesticated animal". The benefactions of civilization, we learn, "range from cocktails and contraceptives to napalm and atomic bombs", and atomic warfare is to be used by those in authority "on any occasion on which they fancy it can be used to their advantage". No proposals are made for putting this deplorable state of affairs to rights, and no moral precepts are born of its contemplation—unless, indeed, that mankind, being deaf to instruction in the true mechanism of evolution, deserves to remain in that despicable situation in which Prof. Wood Jones finds it now to be.

P. B. Medawar

MEDICAL SCHOOLS OF THE WORLD

World Directory of Medical Schools

Répertoire mondial des Écoles de Médecine. Pp. 220. (Geneva: World Health Organization, 1953.)

THE data of this directory are arranged alphabetically by countries (according to their English names) and within countries by cities; in a few cases the countries have been sub-divided into large political or administrative units. Where there are two or more institutions in a city, they are listed alphabetically. The index of geographical names covers all the countries, their sub-divisions and towns. The details of each institution are arranged in thirteen columns spread across pairs of pages and giving the following information: the name of the institution; the year of its foundation; the auspices under which it operates and/or the body or persons responsible for its management; the academic year during which it functions; conditions for admission; the numbers, full-time and part-time, respectively, of the teaching staff; the numbers, men and women, of students; the numbers of students admitted annually; the language of instruction; duration of studies; degrees obtainable; the annual numbers of graduates; and the annual tuition fees (given in local currency). All the entries are given in both English and French.

The directory is admirable in its intent and fulfilment thereof, so that a discordant note in this notice may be considered by some to be churlish. However, in the interest of practical economy, is it necessary that the book be twice as long as it need because of the diligent (nay, fanatical) duplication of every entry in English and French (even to the extent of the index!)? It is almost an insult to the intelligence of French-speaking persons that "3 years in an accredited college or university" needs to be translated into "3 années d'études dans une université ou un ≪collège≫ reconnus"; and though the British are notoriously insular and ill at ease in any but their own tongue, they are surely not so dull as to need to be told that "Diplôme delivré par une faculté de médecine" means "diploma issued by a medical faculty". These are not isolated examples, but rather are characteristic of the whole volume. Nor does the criticism end there. For the twenty-one Italian institutions (occupying more than seven pages), in the columns giving the conditions for admission, the language of instruction and the degrees obtainable, the items are all identical and are repeated each time.

Thus, to sum up, the World Health Organization has performed a valuable service in producing this directory. The book excels in fulfilling its purpose, but does so at an unnecessary expense that might perhaps have been better used to further the magnificent work which the Organization does in the relief of human suffering.

A NEW FUNGUS FLORA

Flore Analytique des Champignons Supérieurs

(Agarics, Bolets, Chanterelles.) Comprenant les Espèces de l'Europe Occidentale et Centrale ainsi que la plupart de celles de l'Algérie et du Maroc. Par Robert Kühner et Henri Romagnesi. Pp. xv + 558. (Paris: Masson et Cie., 1953.) 7970 francs.

A GREAT deal of work has gone to the making of this ambitious flora, which takes the form of descriptive dichotomous keys to the families, genera and some two thousand species of the larger European and many North African fungi. Notes and critical observations on approximately eight hundred species, additional to those in the keys, are appended and many excellent drawings depicting microscopic details of spores, cystidia, cuticle hairs, etc., add to the usefulness of the book, which includes an index, glossary, tables of abbreviations and references to the main periodicals and literature cited. The authors, two mycologists well known for their many publications on Agarics, have incorporated in their present work much recent monographic research previously scattered in different and, often, inaccessible journals.

The system of classification adopted is modern, that is, it approximates so far as possible to a natural classification, and differs notably from that of Fries. As the latter method is still largely used by many mycologists, comparative tables have been made, that is, (1) key summarizing the classification used by the authors, (2) key to the Friesian genera and subgenera, and (3) keys correlating the two systems.

The flora comprises the Agaricaceae, Cantharellaceae and Boletaceae, resupinate and bracket forms being omitted.

The Boletaceae are divided into two main groups: the poroid Boletaceae and the lamelloid, the latter being represented by *Phylloporus*, *Gomphidius* and *Paxillus*.

The Agaricaceae are subdivided into Russulaceae, Amanitaceae, Volvariaceae, Lepiotaceae, Coprinaceae and Rhodophyllaceae, which form one group, and the Boletaceae lamelleae (an overlapping section), Naucoriaceae (including Cortinarieae), Hygrophoraceae, Marasmiaceae, Tricholomaceae and Pleurotaceae making up a second group.

However admirable, a work such as this cannot fail to receive some adverse criticism. The most serious fault, in this instance, is that about eighty species or varieties new to science are described within the body of the keys, with no Latin diagnoses or type specimen citations; and, moreover, nowhere

are they listed separately, nor are they in any way distinguishable as new in the index.

Another disadvantage is that the authors set up their own rules of nomenclature, for example, adopting Fries's "Epicrisis", 1836–38, as the starting point for generic names instead of the "Systema Mycologicum", 1821–32, in accordance with the International Code of Botanical Nomenclature 1952. Lesser criticisms include unsatisfactory citation of literature and the variable spore magnifications, some being × 1,000, others × 2,000.

In spite of these drawbacks, the flora will be much consulted by students of special groups as well as by any amateurs who can gain access to a copy. The cost of the volume will make it well-nigh prohibitive even to many research institutes. Pilat's "Agaricales: Agaricalium Europaeorum clavis dichotomica" 1951 (unfortunately in the Czech language), with which it has much in common, includes 240 pages of photographs yet costs only £5 11*s*., bound, compared with nearly £8, at the present rate of exchange, for the unbound French flora.

The publishers are to be congratulated on the excellent format and type. F. L. Balfour-Browne

ECONOMIC ORGANIZATION FOR WAR

The Control of Raw Materials

By J. Hurstfield. (History of the Second World War: United Kingdom Civil Series.) Pp. xv+530. (London: H.M. Stationery Office, and Longmans, Green and Co., Ltd., 1953.) 35*s*. net.

TWENTIETH-CENTURY war economies are necessarily planned economies, that is, economies in which all major economic decisions are made by governments and carried out by agencies of the State. In war the conditions required by a freely operating price system to secure the production and distribution of commodities and services cease to exist, and therefore the price mechanism must be supplemented by an elaborate system of controls over every aspect of economic life. The volumes in the "United Kingdom Civil Series" on the "History of the Second World War" are adding greatly to knowledge of the economic problems of administration in war, and Mr. J. Hurstfield's study of the control of raw materials is a very important addition to the series.

The task which confronts the historian of war-time raw material controls is a formidable one. Many hundreds of raw materials ultimately came under some form of government control. Mr. Hurstfield has not, however, attempted to write the history of individual controls but has wisely preferred to review the essential features of war-time policy as it affected raw material requirements, supply and allocation, and to illustrate the development of particular aspects of policy by the experience of the more important controls of raw materials such as iron and steel, timber, wool, cotton, flax and rubber.

The volume is divided into four parts, and contains a series of excellent appendixes giving many of the data upon which Mr. Hurstfield's conclusions have been based. Part 1 deals with the pre-war preparations for the supply of raw materials in war. In this section Mr. Hurstfield reviews the relevant economic history of the inter-war years, discusses the steps initiated by the Committee of Imperial Defence "to co-ordinate the war supply arrangements of the Defence Services" and gives an excellent account of the establishment of the machinery of control, the selection of controllers drawn from the trades of which they had experience, and the controversy over the creation of the Ministry of Supply. The conclusion which Mr. Hurstfield reaches is that, although important preparatory work was carried out, "it proved impossible fully to prepare for total war without experiencing total war". The assumption of pre-war planning arrangements tended to be that "the war would be a war of limited liability and many aspects of economic life had reasonable hopes of surviving intact". The fallacy of this assumption was made plain by events.

Part 2 is concerned first with the difficulties of definition, estimation and administration which beset the war-time planners, and secondly with the detailed estimates of requirements of specific sections of the economy, particularly with those for the Armed Services, the export trade and the civil population. Without doubt the most interesting and crucial of the topics considered in this section of the study is the development of the system of allocation in place of the so-called system of priorities. Experience proved that allocations made possible more consistency in planning than was possible by the issue of priority certificates. The allocation versus priority controversy came to a head in the summer of 1940 in the struggle between the Ministry of Supply and the Ministry of Aircraft Production over the availability of alloy steel and drop forgings. "The battle between the two Ministries," says Mr. Hurstfield, "was fought out at the Materials Committee and in the Cabinet, and unofficially in the production offices of private firms."

Part 3 examines with a wealth of detail the economic and financial problems which arose in maintaining the flow of imported raw materials under the changing fortunes of war. The vulnerability of the United Kingdom in war arises largely from her dependence upon imports of food for her human and animal populations and upon a wide range of imported raw materials for her industries. A continuous flow of supplies was essential for her survival. Mr. Hurstfield therefore discusses the changes in import policy and programmes made necessary by changes in the war situation. He has also much of interest to say about a whole series of related topics, including Anglo-American and Anglo-French relations, the replacement of imported materials by home production, the use of substitutes and the conservation of supplies, the growth of State purchasing and the difficult subject of war-time price policy for raw materials.

Finally, in Part 4, Mr. Hurstfield returns to the question of the staffing of the raw materials controls and concludes with an account of the machinery for controlling the controllers of the controls. On the first of these issues it cannot be denied that "the Second World War was fought on the basis of employing to the maximum the ordinary channels of trade". On this controversial subject Mr. Hurstfield is non-committal. He might, however, easily have concluded that any "potential disadvantages" from employing officers drawn from the trades to staff the controls was entirely outweighed by the experience, competence, enthusiasm and unwavering loyalty of the men who were in no small measure responsible for the equipment of the British Armed Forces on land, sea and air in every quarter of the world. E. D. McCallum

ACCELERATION OF PARTIALLY STRIPPED HEAVY IONS

By Dr. ROBERT S. LIVINGSTON
Oak Ridge National Laboratory, Oak Ridge, Tennessee

THE acceleration of large currents of partially ionized nitrogen atoms in the 63-in. cyclotron at the Oak Ridge National Laboratory during the past year has firmly established a new approach to the design of accelerators for the study of high-energy, heavy-particle reactions.

The acceleration of sextuply charged carbon ions has been studied with the 60-in. cyclotron[1] at Berkeley and the 170-in. cyclotron[2] at Chicago. Multiply ionized beryllium, carbon, nitrogen, and oxygen have been accelerated in the 60-in. cyclotron[3] at Birmingham. In these machines it has become accepted that the ions produced in the ion source are probably doubly charged particles, some of which are accelerated at a sub-multiple of the oscillator frequency until they are further stripped of electrons by collision with residual gases. The stripped ions are then accelerated to their final energy at the fundamental frequency of the oscillator. The ion currents which have been achieved in this manner have proved useful, but are considerably lower than one would desire for research in the heavy-particle field.

In an effort to obtain larger currents of heavy ions with a more uniform energy distribution, the acceleration of partially stripped ions (N^{3+}) was undertaken at the Oak Ridge National Laboratory. (The use of partially ionized particles was suggested by Prof. Gregory Breit.) This more direct approach has been successful primarily because of the development of an ion source which produces partially stripped ions at relatively high ion output.

With this new 63-in. cyclotron (Fig. 1) at Oak Ridge, it has proved possible to obtain more than 50 μamp. of 25-MeV. N^{3+}. The purpose of this article is to describe briefly this heavy-particle cyclotron, its ion source, and some of the nuclear results which have been obtained; and to suggest some of the potentialities of this new approach for long-range research in nuclear physics and nuclear chemistry.

The 63-in. Cyclotron

In basic design, the cyclotron is a conventional fixed-frequency machine; its unique feature is the ion source used to produce partially stripped ions. A hot-cathode type ion source[4] (Fig. 2) is used in which a high-intensity arc discharge is initiated and maintained by electrons emitted from a heavy tantalum filament heated by about 400 amp. direct current. The arc is contained in a cylindrical

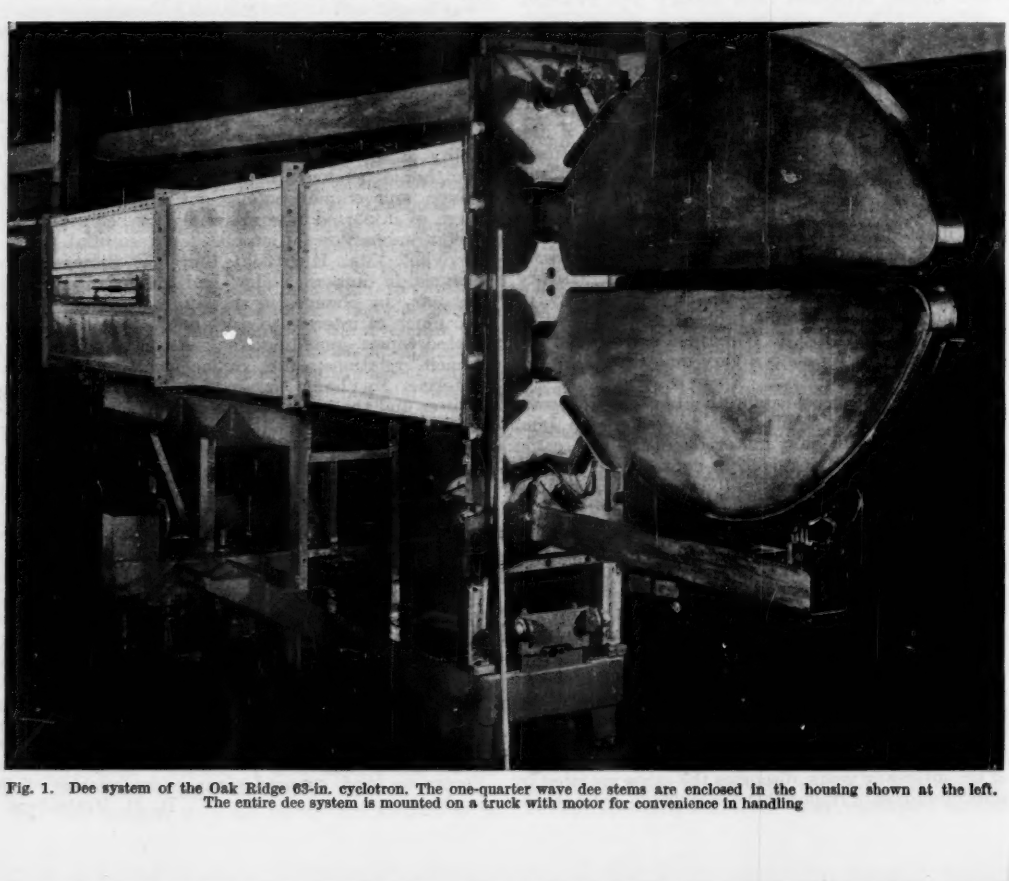

Fig. 1. Dee system of the Oak Ridge 63-in. cyclotron. The one-quarter wave dee stems are enclosed in the housing shown at the left. The entire dee system is mounted on a truck with motor for convenience in handling

chamber of graphite; this material has proved to be very satisfactory, as it requires no water cooling and does not erode excessively. An insulated 'anode' at one end of the chamber reflects the primary electrons and thereby increases the intensity and efficiency of the discharge. Partially stripped ions are emitted only when the arc voltage and current are set to provide an intense discharge and when the gas pressure is reduced sufficiently to minimize recombination. Ions issuing from a slit in the wall of the chamber are accelerated through a precisely aligned accelerating slit (feeler) mounted on one of the cyclotron dees. More than 20 m.amp. of N^{3+} has been obtained in bench tests of this ion source, with a D.C. accelerating potential.

The pole pieces of the cyclotron magnet are disks of iron 4 in. thick and 63 in. in diameter, and the magnet gap is 6 in. As in the 86-in. cyclotron[5] at Oak Ridge, the median plane of the magnetic field is vertical. Care has been taken to remove azimuthal inhomogeneities and to maintain an appropriately precise median plane. The magnetic field at the centre is 15,500 oersteds, and the poles have been shimmed to provide a linear 2 per cent drop-off for magnetic focusing.

The resonant frequency for the acceleration of N^{3+} ions is 5·1 Mc./sec. The radio-frequency system includes a 100-kW. earthed-grid oscillator using an *RCA*-5770 triode with the output inductively coupled to the dee stems by a lumped-circuit equivalent to a half-wave transmission line. A similar coupling is used in the filament line. Through the use of variable vacuum condensers in both the plate and the filament coupling circuits, provisions are made for adjustment of the phase and magnitude of the feedback voltage and for changing the plate load impedance. Experience with the Oak Ridge 86-in. cyclotron had demonstrated that placing a negative bias of approximately 1,000 volts on the cyclotron dee system is effective in eliminating ion-loading difficulties which have often been experienced with other fixed-frequency cyclotrons. Consequently, the dees were insulated to permit the use of a negative bias. The cyclotron operates reliably at the desired frequency with dee-to-earth voltages of 35–50 kV.

The dees are mounted in a vertical plane and surrounded by a copper-plated stainless-steel liner. A section through the cyclotron is shown in Fig. 3. The dee assembly can be removed from the vacuum chamber without moving the liner. The dees are mounted on zircon bushings, since their point of entrance into the vacuum system is at high radio-frequency potential and at 1,000 V. negative bias potential. External adjustments have been provided which make it possible to shift the dees vertically and horizontally without interrupting the operation of the cyclotron.

The 17-ft. dee stems, required by the resonant frequency, project outside the vacuum chamber and are shielded by a copper box 3 ft. × 1·5 ft. × 18 ft. The plate and filament coupling coils are inside this shield, between the dee stems. The liner, dees, dee stems, and deflector are all water-cooled.

The vacuum pumping system consists of two 20-in. oil diffusion pumps in parallel, each backed by an 8-in. oil diffusion pump. This arrangement gives a total pumping speed of 12,000 litres per sec. at a pressure of 3×10^{-5} mm. mercury. The fore-vacuum is provided by a 5-h.p. Kinney pump. The ultimate vacuum in the cyclotron tank is approximately 1×10^{-6} mm. mercury.

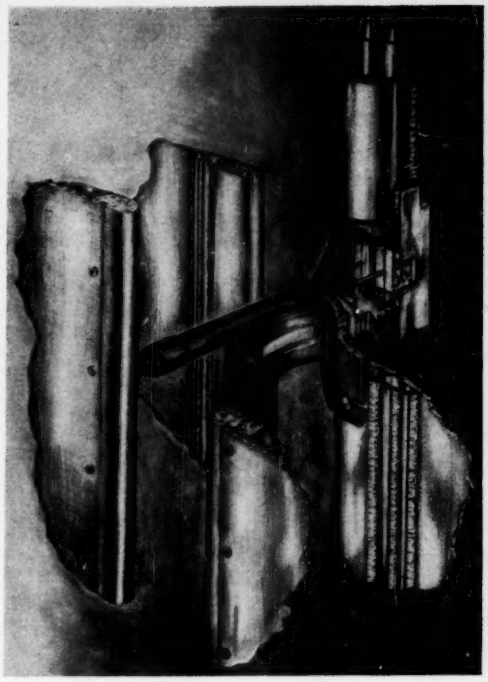

Fig. 2. Sketch of the ion source used. The position of the accelerating electrode ('feeler') mounted on the lower dee is shown. (The position of the dees and ion source is rotated 90° to the left for convenience in illustrating)

Preliminary Nuclear Measurements

The nitrogen ions have been used to bombard deuterium, beryllium, boron-10, boron-11, carbon, nitrogen, oxygen, and sulphur[6,7]. Half-life measurements and gamma-ray spectra, obtained with a scintillation spectrometer, have been used to identify radioactive reaction products. The relative thick-target yields for twenty reactions have been established, and upper limits for relative yields placed on many reactions which are energetically possible. It appears that the cross-sections of the reactions studied are of the order of 10^{-26} cm.^{2}, the largest observed cross-section being that for $^9Be(^{14}N)^{19}F\ ^4He\ n$. (Since the products for many reactions have nearly equal charge and mass, the target nucleus is given first, the bombarding heavy particle is in parentheses, and all reaction products are listed at the right.) The reactions observed seem to fall broadly into two classes. First are those in which the two heavy particles appear to exchange a light particle, with subsequent emission of a gamma-ray or an additional light particle, for example, $^{10}B(^{14}N)^{13}N^{11}B$; second, those in which all of the nuclear matter fuses except for a few nucleons, as $^{32}S(^{14}N)^{44}Sc\ 2^1H$.

Range–energy relations of nitrogen ions in the energy region where the charge is a function of velocity have been investigated with the cyclotron beam. Ilford *C*-2 emulsions were bombarded for short periods of time by a highly attenuated beam of nitrogen ions. After bombardment, the emulsions were surveyed for proton recoils resulting from elastic nitrogen–proton scattering. To date, approximately one hundred events have been used to obtain a

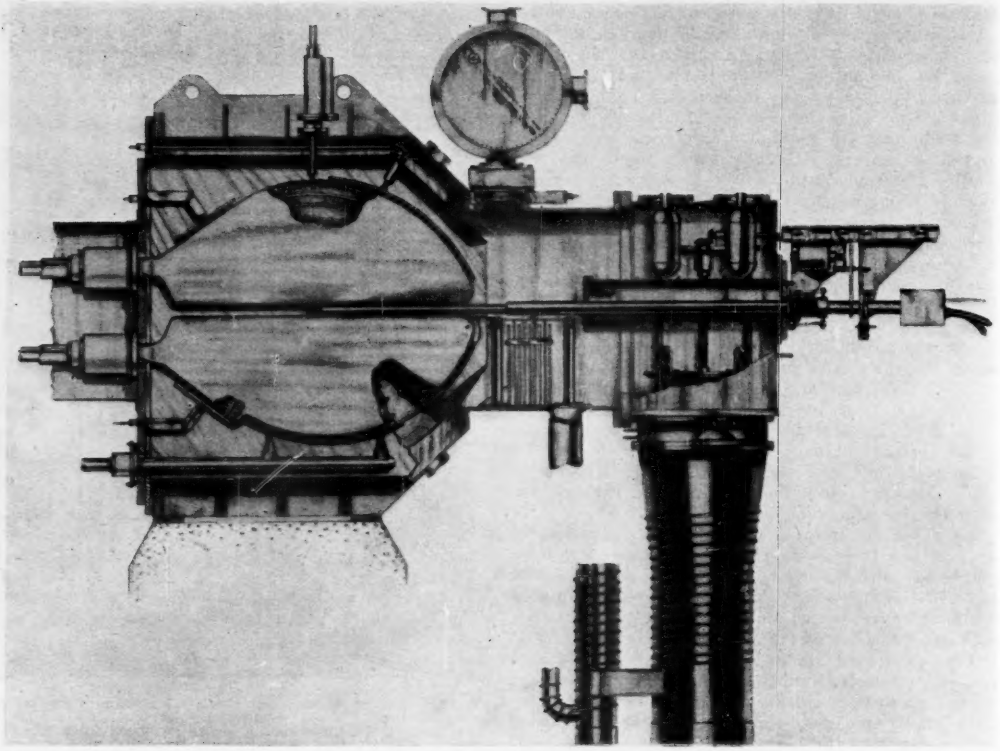

Fig. 3. Section through vacuum tank of the Oak Ridge 63-in. cyclotron. The deflector in the lower dee removes N^{3+} ions from the dee and directs them into the gas-target chamber above. The resonant dee system is insulated on zircon bushings shown at the left. The ion source is mounted on a long stem inserted through the vacuum manifold at the right. A probe for measuring the internal circulating beam is inserted through the top of the vacuum tank, into the upper dee

range–energy curve in emulsions for nitrogen ions between 3 and 20 MeV.[8].

The energy-spread of the circulating beam of a cyclotron is usually rather large. This spread has been measured in the 63-in. cyclotron with nuclear emulsions and has been found to be of the order of 9 MeV., half-width at half-maximum. For bombardments at the radius used in most of the experiments, namely, 24¼ in., the bulk of the beam was between 14 and 23 MeV., with a small tail extending out to 31 MeV. The average energy was 19 MeV. Recently, the beam in the cyclotron has been successfully deflected; 1 μamp. of N^{3+} has been measured in a Faraday cup outside the machine. The energy-spread of this deflected beam is much smaller, although the precise determination of the spread has not been completed.

Synthesis of Transuranic Elements

Success in achieving relatively large currents of 25 MeV.-nitrogen ions leads logically to a consideration of methods for obtaining comparably high currents with sufficient energy to produce reactions in the heaviest elements. Research in nuclear chemistry and nuclear physics has been limited by the dearth of methods for making the elements above plutonium in large quantities and with a wide range of mass numbers. In general, only the isotopes accessible from simple neutron capture on available elements have been produced in adequate amounts. The quantities of the isotopes produced in accelerators (from bombardment with C^{6+} or He^{2+}) have been, in most cases, very meagre.

Our group has considered this problem, and we believe it to be entirely feasible to construct an accelerator which will produce many of the possible nuclear species up to atomic number 104 and mass 260. According to our view, this machine would be a large, approximately 100-in., fixed-frequency cyclotron designed to accelerate partially stripped boron, carbon, nitrogen, oxygen, fluorine and neon.

The oscillator frequency and the magnetic field controls could be designed so that both could be pre-set by push-buttons for resonance with any desired particle. Tests at this laboratory have shown that an oscillator can be designed to operate through the appropriate frequency-range, and that electromagnetic shimming coils can supply the properly shaped magnetic fields through the desired range of average absolute intensities of magnetic field.

The energy of the nuclei accelerated would be determined by the number of electrons stripped in any given case; but, for triply and quadruply charged ions, would range from 100 to 225 MeV. Approximately 70–90 MeV. is required for penetrating the Coulomb barrier of uranium or plutonium. However, it is desirable to obtain an energy substantially in excess of this in order to permit the use of thin windows for targets which are radioactive, and

to provide additional range of the bombarding particle in cases where large yields are needed. It should be possible to obtain internal beams of 50 μamp. of carbon, nitrogen, oxygen, fluorine, and neon in such an accelerator and to obtain deflected beams of several microamperes. The possibilities for the enrichment of basic nuclear knowledge with such an accelerator are obviously abundant.

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STRUCTURE OF PROTEINS

DURING September 21–25, 1953, a conference was held by invitation of Prof. Linus Pauling at the California Institute of Technology in Pasadena, to discuss progress in X-ray studies of the structure of proteins (and to a lesser extent of nucleic acids). The last conference of this kind was that arranged by the Royal Society and held in London during May 1952 [1]; it had been the first to include a full-scale discussion of the new polypeptide chain configurations proposed by Pauling and Corey, especially the α-helix. At the conference now to be described, less that was quite new emerged; rather it was a much-needed consolidation of ideas which have been circulating during the past year or two. It revealed a larger area of agreement between various schools of thought than had ever before been apparent.

The most general and fundamental concept underlying the discussions was that helical arrangements are at the basis of many important biological structures, either at the atomic level as a type of configuration for long-chain molecules, or at the molecular level as a way in which larger units of structure may naturally aggregate. Although a helical model had been proposed for the polypeptide chain by H. S. Taylor as early as 1941, and similar schemes had been discussed by Huggins[2] and others, it cannot be said that the helix as a structural principle had entered into the fundamentals of our thinking up to the time of the Royal Society conference: indeed, on that occasion there was strong disagreement as to the existence of helical chains. The Pasadena conference revealed that the helix has now come into its own with a vengeance; finding helices is a game played by nearly everyone in the field, and there are now few biologically important structures which are not thought, by some workers at least, to be helical. This change—or it would scarcely be too much to say, revolution—has of course been facilitated by the development of methods whereby the helical nature of a structure can be inferred, often at a glance, from its X-ray pattern[3].

In this brief account of the proceedings it will be impossible to report on all the papers presented or the discussions which followed them; it will be more useful to concentrate on a few major topics, excluding those in which the latest developments have now been published. The most important was the α-helix itself and related chain models. It would appear from the discussion at this conference that an increasing number of workers in the field would now agree that the α-helix is the basic chain configuration present in α-polypeptides and α-forms of fibrous proteins; the discussion centred not so much about evidence for the existence of the α-helix as about details such as the modes of aggregation of helices, methods for turning corners, and evidence for left- or right-handedness, etc., mainly in reference to fibrous proteins. Thus L. Pauling (California Institute of Technology) discussed ways in which bends or even corners might be introduced into the α-helix if proline residues were introduced at appropriate points. Proline, since it is an imino- rather than an amino-acid, and since its shape is unusual, *must* break the sequence of hydrogen bonds in the chain and cause it to kink; for some time the idea has been current in a general way that prolines might be associated with the turning of the corners which must result from folding up a polypeptide chain into a globular protein molecule, and with the secondary twisting which has been postulated in α-keratin. Pauling, by introducing a 16-membered ring (or rings) in the neighbourhood of the proline, reduces to a minimum the number of hydrogen bonds broken and causes the whole chain to bend through a definite angle. However, it turns out that there are several ways, all nearly equivalent energetically, in which this can be done, each resulting in a different angle of kink; and none of the models so far proposed has that quality of inevitability which would cause one to prefer it above the others.

There was also discussion by Pauling and F. H. C. Crick (Cambridge) of the mechanisms they have proposed[4,5] for coiling the chains into 'super-helices' which might account for the longer periodicities in fibrous proteins. Another possible basis for long-range order was discussed by W. T. Astbury (Leeds) and R. S. Bear (Massachusetts Institute of Technology), namely, linear or helical aggregation of globular protein particles to form fibrous structures with long periodicities. Astbury showed that there were analogies between the myosin–actin system of muscle and the structure of bacterial flagella; the low-angle X-ray pattern of flagella has spacings very similar to those of actin. He suggested that many fibrous proteins are made up of two components in parallel, the separate identities of which may be revealed in the X-ray pattern. Bear showed how by simple manipulation of the diffraction theory of helices it is very easily possible to recognize the presence of a helix in a fibrous diffraction pattern; he illustrated his 'selection rules' by applying them to paramyosin, 'type II' myosin, porcupine quill and feather keratin.

Thus there are two main types of theory to account for the long-range order of protein fibres; first, a secondary twisting of the helical protein chains, and second, a helical aggregation of globular protein particles. Some discussion of the relative merits of these theories revealed no consensus of opinion in favour of one or the other and, of course, as was pointed out, they are not mutually exclusive.

An account was given of other helical structures which might be expected on energetic grounds to have a stable existence. Barbara Low (Harvard) described her π-helix[6], and J. Donohue (University of Southern California) compared the stabilities of several helical chains, including a revised version of the α_{II}-ribbon and new helices proposed by himself[7]. Although all these models are plausible, there seems at present to be no evidence that they actually exist

in any real structure. One type of evidence which has been used to identify chain configurations was discussed by D. P. Riley (Royal Institution, London), namely, the measurement of radial distribution curves and their comparison with radial distributions calculated from model structures. A good deal of discussion of this method in various contexts failed to reveal any unanimity as to its diagnostic value; nevertheless, the striking differences between different test substances found by Riley and Arndt suggest that this technique deserves close attention.

R. E. Marsh (California Institute of Technology) discussed the structure of silk in terms of the antiparallel-chain pleated sheet of Pauling and Corey[8]; this is one of the few remaining structures not generally considered to be helical. I. F. Trotter (Courtaulds, Ltd.) exhibited some beautiful X-ray pictures of silk and of β-poly-L-alanine, and showed that these two materials are virtually isomorphous.

We may now turn to the structure of collagen. The situation in this field is remarkable in that there is at this time no model of the chain configuration of collagen which commands support; indeed, most of the many proposed have been tacitly or explicitly withdrawn by their authors. In the discussion of this topic a number of new experimental results were described, especially the discovery by Cowan, North and Randall[9] that by keeping a collagen fibre stretched during the X-ray exposure the main meridional reflexion at 2·86 A. can be extended as much as 14 per cent, and that at moderate extensions (for example, 5 per cent) the quality of the photographs greatly improves, many new reflexions being observed; similar results were reported by R. Pasternak (California Institute of Technology). There was also some discussion about the admissibility of the evidence produced some years ago by Schmitt, Hall and Jakus[10] that under special conditions (on the electron microscope grid) the collagen chain can be extended as much as 100–200 per cent; clearly this result, if accepted, would exert a decisive influence in model-building experiments. W. T. Astbury mentioned a recent claim by K. M. Rudall to have obtained the collagen of worm cuticle in a β-form. An important theoretical contribution was made by R. S. Bear who, by applying his 'selection rules' to the collagen X-ray pattern, derived a helical 'net pattern' of scattering centres which satisfies the data, but pointed out that chemically speaking these centres could be connected in various ways, giving either multiple helices of steep pitch or a primitive helix of shallow pitch—in his view the latter is to be preferred as allowing a long-range extensibility. Finally, F. O. Schmitt (Massachusetts Institute of Technology) introduced a discussion of the larger aspects of collagen structure, with special reference to pro-collagen and the various types of reconstituted collagen, especially a newly discovered form of 'segment long-spacing' particle[11]. He also described a striking result obtained by Hodge in his laboratory: solubilized para-myosin can be reconstituted by methods analogous to those used for collagen, giving cross-striated fibrils exhibiting a periodicity of 1400 A.

An important contribution to studies of muscle structure was made by H. E. Huxley (Cambridge and the Massachusetts Institute of Technology), who described work by himself and Jean Hanson (King's College, London, and Massachusetts Institute of Technology) using the techniques of X-ray diffraction and electron and phase-contrast microscopy[12]. They have shown that the essential difference between the *A* and the *I* bands of striated muscle is that in the former there are parallel fibrils of myosin as well as of actin, whereas in the latter there are actin filaments alone. In the *A* bands the myosin fibrils (diameters *c.* 110 A.) lie in hexagonal packing 2–300 A. apart; in absence of adenosine triphosphate, when the muscle is inextensible, the actin filaments (diameters *c.* 40 A.) lie between them in symmetrical hexagonal array, but on addition of adenosine triphosphate they acquire freedom of motion and the muscle loses its rigidity. The suggestion is, in fact, that when muscle is stretched the actin filaments are pulled out from between the myosins just as a tendon is pulled from its sheath.

The structure of the crystalline proteins occupied a good deal of the attention of the conference. A significant advance in the attack on the structure of hæmoglobin was reported by Sir Lawrence Bragg and M. F. Perutz (Cambridge). The former described the tactics employed in a direct attempt to obtain the phases of the *h0l* reflexions of monoclinic horse hæmoglobin. Details of the earlier stages of this attempt have been published[13]; the essence of the method is to derive the Fourier transform of one projection of a *single* molecule from the superposition of the diffraction patterns of ten different shrinkage stages, in each of which the molecules have the same orientation; if this transform were completely determined, the distribution of electron density in the projection could be derived unambiguously. It turns out, however, that the transform cannot be completely determined; many relations between the signs of reflexions are deduced, but no unique solution can be derived.

M. F. Perutz then reported a fresh attack on the problem using the classical 'heavy atom' method. This consists in finding a heavy atom which can be attached to the molecule under investigation in such a way that crystals of the complex and of the original substance are isomorphous; the two will give slightly different diffraction patterns owing to the presence of the heavy atom in one. If the actual position of the heavy atom in the unit cell can be found (which is generally straightforward) the structure can be solved directly. In horse hæmoglobin the heavy atom was mercury; each molecule contains two free —SH groups which can be substituted by chloro-mercuribenzoate. The resulting derivative can be crystallized and proves to be exactly isomorphous with the normal crystals, but the intensities of some of its reflexions are significantly changed. A 'difference Patterson' clearly reveals the Hg–Hg vector; the positions of the mercury atoms in the unit cell can actually be determined within 1 A. Hence the signs of about half the hundred reflexions of spacing greater than 6·3 A. were established with some certainty. These signs in general agreed with the relations determined by the transform method and in some cases could be used to resolve ambiguities in that treatment. By combining the results of the two methods, the signs of all hundred reflexions were deduced and were used to calculate an electron density projection of the hæmoglobin unit cell. Few obvious features of the molecule emerge from this projection (except that there are indications of a line of cleavage across the molecule, the division of which into two equal halves is expected on other grounds), and greater resolution is evidently desirable. Nevertheless, the calculation of this projection is a most important step forward, since in contrast to previous

methods there seems little doubt of its correctness, and because there seems no reason in principle why it cannot be extended to higher resolutions.

Other results in this field were reported by Barbara Low, by D. Harker (Brooklyn Polytechnic) and by J. C. Kendrew (Cambridge). Barbara Low described the three-dimensional Patterson synthesis of dry orthorhombic insulin, and gave evidence that it contains parallel rods of high vector density corresponding to polypeptide chains; she also described model-building experiments in which the amino-acid sequence derived by Sanger is used to investigate the topological possibilities of linking the chains together by means of —S—S— bridges. D. Harker gave details of the counter apparatus designed in his laboratory, by the use of which the intensities of 2,500 reflexions from a protein crystal could be measured with an accuracy of ± 10 per cent in six working days; there was discussion here of discrepancies in the measurement of absolute intensities of standard crystals. J. C. Kendrew described the main features of some ten new crystalline forms of myoglobin, derived from various species of whales, seals and penguins (in collaboration with R. G. Parrish and M. M. Bluhm). He also showed a Fourier projection of one form of whale myoglobin in which it is believed that the chains are viewed end-on. This was obtained by application of Cochran's inequality relations, and consists of two layers of three chains each; it is compatible with other evidence but at present cannot be proved to be correct.

There were discussions of other topics which will be mentioned only briefly. Thus one session was devoted to the Watson–Crick structure of deoxyribonucleic acid[14], and M. H. F. Wilkins (King's College, London) gave an account of a detailed study of the X-ray pattern which strongly supports this structure[15]; A. Rich (California Institute of Technology) also described X-ray studies of deoxyribonucleic acid. Accounts were given of recent investigations of the crystal structures of peptides; especially of glycylasparagine (R. Pasternak) and of N,N′-diglycyl cystine (E. W. Hughes, California Institute of Technology). V. Luzzati (Brooklyn Polytechnic) described his investigations of the statistical distribution of intensities of reflexions from protein crystals; he finds that the relations shown by A. J. C. Wilson to be valid in crystals of simple compounds may give misleading results if applied directly to proteins, and has himself developed methods more appropriate to complex structures. Finally, there was a discussion of the infra-red spectra of proteins led by G. B. B. M. Sutherland (Ann Arbor) and A. Elliott (Courtaulds, Ltd.); the complexity of these spectra is such that great caution must be exercised in interpreting them.

In my own view and, I believe, in that of many others present, the conference was the most successful ever held in this field. Its success was due partly to the most liberal hospitality of its hosts, and partly to certain features of its organization: that it included representatives of virtually every group working in the field, that attendance was restricted to protein crystallographers and a very few closely associated workers, enabling discussions to be conducted at a technical level, and finally that the meetings extended over five days, so that discussion could be exhaustive. The conference was made possible by the support of the Rockefeller Foundation, the National Foundation for Infantile Paralysis, and the American Institute of Biological Sciences in conjunction with the Office of Naval Research; to all these organizations, and especially to Profs. Pauling, Corey, and Hughes and their staff, those present at the conference owe a great debt.

J. C. KENDREW

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OBITUARIES

Prof. C. L. Huskins

CHARLES LEONARD HUSKINS, who died at the age of fifty-five in Madison, Wisconsin, on July 26, 1953, was a leading figure in the study of the structure of chromosomes, and in relating the morphological and dynamic aspects of nuclear cytology to genetic behaviour and to cellular function and differentiation.

Huskins was born at Walsall, Staffordshire; when he was nine the family moved to Red Deer, Alberta. During the First World War Huskins served with the 187th Battalion, Canadian Infantry, and as a pilot in the Royal Flying Corps. Returning to the wheat-growing west of Canada, his interests turned to cereal production and the sciences underlying it, and he studied botany and plant breeding at the University of Alberta, receiving the M.S. degree in agriculture for work on the origin of false wild oats. In 1925 he was awarded an 1851 Exhibition scholarship to study for his Ph.D. under R. R. Gates at King's College, London, where he was much influenced by Bateson and his colleagues. The fast-growing field of plant cytogenetics captivated him, and during 1927–30 he was research fellow at the John Innes Horticultural Institution. During this time he travelled widely in Europe and contributed a number of papers on the cytology of cereals and other plants in relation to their breeding behaviour and evolution. He received the D.Sc. of the University of London in 1934.

In 1930 Huskins was appointed associate professor of botany at McGill University. He entered enthusiastically into teaching, and into initiating a Department of Genetics, the first of its kind in Canada, which was formed under his chairmanship in 1934. In his teaching and in building up the research facilities of the Department, Huskins was guided by his energetically expressed belief in the fundamental importance of genetics in biological thought and its value to social and medical science. This belief, coupled with his vigorous personality and wide interests, brought into contact students, colleagues

and friends of diverse disciplines and outlook, and added much to the life of the University and of the wider community. While continuing, together with his students, the cytogenetic study of oats and wheat, his published papers of this period and later cover many fields of interest, notably the structure of chromosomes and their behaviour at meiosis, atypical features of cell division in relation to the cancer problem and the role of the nucleus in growth and differentiation.

Huskins was invited to a professorship in botany in the University of Wisconsin in 1945. He left Canada with many regrets, but kept in close contact with colleagues and friends there and with the Royal Society of Canada, of the Biological and Medical Sciences Section of which he was president in 1951. At Wisconsin he devoted much energy to general questions of education and helped to formulate and put into action the University's programme of integrated liberal studies.

In 1923 Huskins married Margaret Villy, a native of Manchester, who was at that time lecturer in English in the University of Alberta. Her steady wisdom and unusual artistic and spiritual qualities contributed greatly to the delight of their home, always generously open to many students and friends. Her death in March of last year, after a long illness, clouded the closing months of Huskins's life. They are survived by two daughters and a son.

In his scientific approach Huskins combined a mistrust of simplification and generalization with a driving desire to find a pattern in diversity. Never content to isolate a problem, however deeply absorbed in it, he always tried to relate his thoughts and findings not only to neighbouring scientific fields, but also to practical, social and philosophical questions. He was a champion of the exception, and throughout his life his receptive and tenacious mind built up a store of intellectual and spiritual valuables which he sought continuously to set into a meaningful pattern. He had great energy and a taste for the purposeful use of time, effort and material. These characteristics were expressed in a love of physical work (he was skilled in many useful crafts), in quick movements and speech, and in a rich imagination promptly and emphatically expressed. To his students he was a buoyantly enthusiastic and versatile personality and a stimulating friend. He will be sadly missed for the fire and colour which he lent to all his enterprises.

Prof. W. K. Fisher

Walter Kenrick Fisher, professor emeritus of zoology at Stanford University, died on November 2 in California. He was born in Ossining, New York, on February 1, 1878, the son of A. K. Fisher, a prominent naturalist and one of the founders of the U.S. Biological Survey. After a boyhood in New York State and Washington, D.C., his entire academic career was associated with Stanford University, from which he graduated in 1901, with a doctorate in 1906. He was early interested in botany, as well as in art, but turned to zoology as the result of summers as field naturalist with the Biological Survey, and two voyages as assistant on the famous *Albatross* expeditions, in 1902 and 1904. The wealth of collections from these cruises and other Pacific sources led him into the taxonomy of the echinoderms, in which he soon became a recognized authority.

Prof. Fisher published "Starfishes of the Hawaiian Islands" in 1906, and in 1911 there appeared "Asteroidea of the North Pacific and Adjacent Waters", a monograph of the U.S. National Museum. Part 2 of this appeared in 1928 and Part 3 in 1930, making nearly a thousand pages. In 1940 he published "Asteroidea", based on the "Discovery" Expeditions. These are, however, but the chief monuments of his work. Dozens of smaller papers, not only on echinoderms but also on other invertebrates, attested his wide competence.

He was a Fellow of the California Academy of Sciences, and was a curator of its collections during 1916–32. He had a continuing interest in ornithology, having been a president of the Cooper Ornithological Society, and an editor of its journal, *The Condor*.

Appointed assistant professor of zoology at Stanford in 1909, in 1917 Dr. Fisher became resident director of the Hopkins Marine Station, a division of the University, which had just moved to new quarters at Pacific Grove. At first almost alone, later with an increasing resident staff, he studied the rich fauna of the Monterey Bay region, and built up the reputation of the laboratory as a year-round centre of biological and oceanographical investigation. He was an effective teacher, influencing the careers of many students.

After his retirement in 1943, Prof. Fisher found time to develop his artistic ability. He had long illustrated his own scientific papers in beautiful manner, but now he could take up oil painting. Many careful still-lifes and portraits displayed his real talent in this direction: texture and the play of colour on surfaces especially intrigued him. Yet he also continued zoological study, as research associate of the Smithsonian Institution, and was working on collections from that Museum, and naming new species, up to the last week of his life.

In a biological science tending strongly in other directions, Prof. Fisher was admired and respected as a great protagonist of accurate, scholarly taxonomic work. As one of his colleagues recently wrote: "Systematic Zoology has lost one of its best friends, because he combined so many fine qualities with so much zoological knowledge". L. R. Blinks

Dr. A. L. Hagedoorn

By the death of Dr. A. L. Hagedoorn, on November 20, genetics has lost one of its most colourful figures. An iconoclast by nature, he entered with zest into controversy, especially where established notions were the object of attack. Indeed, it was the lure of battle that brought him as an eager recruit into the Mendelian camp in the early days. But argument never soured Hagedoorn; he remained eager, full of wit and zest, always good-tempered and genial, and always ready with help, advice and encouragement.

Hagedoorn was born in Amsterdam in 1885 and studied at the University there for a short while before going to the United States in 1909, where he studied under Loeb at the University of California, obtaining his doctor's degree for a thesis on "The Purely Maternal Characters of the Hybrids produced from Eggs of Strongylocentrotus". He was one of the small band of early Mendelian experimenters, doing pioneer work mainly with mice and to a less extent with rats, guinea pigs and rabbits. He was quick to point out the analogies in the inheritance of coat colours in rodents, though he failed to formulate the generalization which some years later

Vavilow propounded as the law of homologous variation. He eagerly joined issue in the controversy about Cuénot's yellow mice, which was not cleared up until Little introduced the idea of lethal factors. Likewise he was in the thick of the dispute about the Himalayan rabbit, a perplexing case before the days of multiple allelomorphs. Throughout his life he stoutly defended against all deviationists the presence and absence theory in its original form.

Hagedoorn's real bent lay in the field of applied genetics. On his return from America, he joined the firm of Vilmorin, the leading seedsmen in France. A few years later, in 1914, he was sent to Java by the Dutch Government to organize the fight against rats in that island. He returned to California in 1916, and then after two years in Berlin with Erwin Baur he settled down in Holland at Soesterberg, where he quickly established himself as a consulting geneticist, both for plant and animal breeders. He also taught in the University of Leyden, and became secretary of the Dutch Genetical Society. He was thus most favourably placed between science and practice, and, with a foot in both camps, he became a familiar figure wherever geneticists or practical breeders were gathered together.

He is best known in Great Britain for his text-book on animal breeding, the tenth edition of which is due to appear in 1954. In 1950 he published a companion text-book on plant breeding, and in 1953, in collaboration with Geoffrey Sykes, he published a book on poultry breeding. His writing is attractive and persuasive, though coloured with an enthusiasm which sometimes got the better of his good judgment. Since 1945 he has been a frequent visitor to Britain, where he lectured to gatherings of live-stock breeders, both of farm animals and of the fancy. His very great knowledge of the practical problems involved, and his very real understanding of the outlook of the practical man, enabled him to talk to breeders in a language they understood. Few geneticists have been as successful as Hagedoorn in conveying to the practical man the importance of Mendelism to the art of breeding.

MICHAEL PEASE

Mr. J. D. Griffith Davies, O.B.E.

A WIDE circle of scientists throughout the world will have learned with regret of the death on December 18 of John David Griffith Davies, who was assistant secretary of the Royal Society during 1937–46.

He was born on January 19, 1899, and went from Monmouth School to Jesus College, Oxford, after a period of war service during 1916–19. He graduated in the Honours School of Modern History in 1923 and after a few years teaching in school he joined the City of Leeds Education Department in 1926; he was appointed assistant secretary of the Royal Society in 1937. It was largely during the period in Leeds that he wrote about a dozen books on historical subjects.

Griffith Davies served the Royal Society under three presidents, Sir William Bragg, Sir Henry Dale and Sir Robert Robinson. With characteristic energy he applied his considerable talents to problems which faced the Society during the period dominated by the threat of war and war itself. He took a leading part in the construction of the Central Scientific Register, which did much to help in the mobilization of British scientific effort. He had to supervise the transfer of the Society's treasures and library to safe quarters. After the War, when the Society again resumed its full scientific activity in peace-time conditions, Griffith Davies was intimately concerned with the organization of the Newton Celebrations and the Royal Society Empire Scientific Conference—two events which were outstanding in the revival of Commonwealth and international scientific relations. In 1947 he was made O.B.E.

On his retirement from the Society's service, he endowed the Wilkins Lecture in the history of science, and although his main interests thereafter were centred on his farm in Gloucestershire, he maintained close contact with the Society's affairs.

He will be remembered with affection by those who came in contact with him in his wide range of interests.

D. C. MARTIN

NEWS and VIEWS

New Year Honours List

THE list of New Year Honours includes the names of the following men of science and others associated with scientific work:

K.B.E.: Commander Seton S. C. Mitchell, controller of guided weapons and electronics, Ministry of Supply.

Knights: Arthur L. Binns, chief education officer for Lancashire; Prof. Edward C. Dodds, Courtauld professor of biochemistry, University of London; Prof. James Gray, professor of zoology, University of Cambridge, member of the Development Commission; Dr. Edward T. Paris, chief scientific adviser, Home Office; Dr. William G. Radley, engineer-in-chief, Post Office; Dr. Douglas Veale, registrar, University of Oxford.

C.B.: A. T. Barnard, chief superintendent, Royal Ordnance Factories, Woolwich; Dr. J. M. Stagg, principal deputy director, Meteorological Office, Air Ministry.

C.M.G.: R. E. Brook, deputy chairman, Colonial Development Corporation; Ian Clunies-Ross, chairman, Scientific and Industrial Research Organization, Commonwealth of Australia; G. S. Dunnett, secretary, Commonwealth Economic Committee; G. Michael Graham, director of fishery research, Ministry of Agriculture and Fisheries; Colonel H. W. Mulligan, director, West African Institute for Trypanosomiasis Research; A. E. Trotman, member for Agriculture and Natural Resources, Tanganyika.

C.B.E.: Dr. D. A. Allan, director, Royal Scottish Museum; W. Allan, director of agriculture, Mauritius; Prof. G. D. Allen, professor of statistics, University of London; H. Cronly, director of veterinary services and animal industry, Uganda; St. J. de H. Elstub, director of the Metal Division, Imperial Chemical Industries, Ltd.; Prof. T. Ferguson, professor of public health, University of Glasgow; Dr. J. B. Firth, director, North Western Forensic Science Laboratory, Home Office; R. D. Gwyther, senior partner, Coode and Partners, consulting civil engineers, London; Miss Kathleen M. Kenyon, lecturer in Palestinian archæology, University of London Institute of Archæology; G. J. S. Little, assistant engineer-in-chief, General Post Office; Dr. K. Mellanby, lately principal, University College, Ibadan, Nigeria; J. H. Nicholson, principal, University

College, Hull; E. T. Osborne, director of chemical inspection, Ministry of Supply; Prof. W. Riddet, professor of agriculture, Massey Agricultural College, Palmerston North, New Zealand; G. Darnley Smith, chairman, Radio Industry Council, managing director of Bush Radio, Ltd.; Dr. B. A. Southgate, director, Water Pollution Research Laboratory, Department of Scientific and Industrial Research; F. W. G. White, chief executive officer, Scientific and Industrial Research Organization, Commonwealth of Australia; Prof. S. W. Wooldridge, professor of geography, University of London, for services to the Ministry of Housing and Local Government.

Principal of University College, Exeter : Prof. J. W. Cook, F.R.S.

Prof. J. W. Cook, regius professor of chemistry in the University of Glasgow, has been appointed principal of the University College of the South West, Exeter, in succession to the late Sir Thomas Taylor. Prof. Cook went to Glasgow in 1939 from the chair in the University of London which he held at the Lister Institute. His Glasgow period has been marked by conspicuous achievement. In addition to the organization and care of a large department of organic chemistry, he has built up a flourishing school in his own and related fields of interest, and has given the strongest support to developments in other branches of his science. The regius professor has the duty of acting as administrative head of the whole Institute of Chemistry at Glasgow—a task which has been particularly heavy since the end of the War. In 1937, the University had begun to erect a very large new chemistry building. By the outbreak of war in 1939, only the first stage of this operation had been accomplished, so that it has fallen to Prof. Cook in the period since 1947 to preside over the completion of the building and its equipment for every form of chemical teaching and research, a task now almost ended. In addition, Prof. Cook has taken a very full share of the administrative business of the University, as a member of the University Court, and as chairman of many committees. He has given much service to the general scientific and industrial interests of the west of Scotland, as well as to his own professional institutions. He has also been a member of the University Grants Committee. Glasgow parts from him with profound regret.

Physical Chemistry at Nottingham : Prof. D. D. Eley

Dr. D. D. Eley, who has been appointed to the newly established chair of physical chemistry in the University of Nottingham, is a Manchester graduate, and after three years research on chemical kinetics with Prof. M. Polanyi, carried out postgraduate work with Prof. (now Sir) Eric Rideal at Cambridge. The latter led to extramural research on explosives problems for the Ministry of Supply during the Second World War. In 1945 he was appointed lecturer in colloid chemistry at the University of Bristol, and in 1951 reader in biophysical chemistry. Dr. Eley has taken a considerable part in the development of an honours school of biological chemistry at Bristol. His experimental investigations have been aimed at the basic mechanisms of inorganic and enzymatic catalysis. His work has included studies on Friedel–Crafts catalysis, polymerization kinetics, polymer rheology, exchange reactions, parahydrogen conversion on metal surfaces, and the solvent action of water and the problems of hydration. In his biophysical work he has made studies on hydrogenase, and on the kinetics of cholinesterase action and inhibition. He has investigated the semi-conductivity of large molecules, including hæmoglobin, with the view of possible applications in enzyme action. His work on catalysis has been recognized both in Great Britain and abroad. Dr. Eley gave the Reilly Lectures at the University of Notre Dame, Indiana, and also has been awarded the medal of the University of Liège. He has played an active part on the Council of the Faraday Society.

Institution of the Rubber Industry : Awards for 1953

The highest award of the Institution of the Rubber Industry, the Colwyn Medal, has been presented to Dr. D. Parkinson, manager of the Compounding Research Division, Dunlop Rubber Co., Ltd., for conspicuous services of a scientific character to the industry. The Hancock Medal for 1953 has been awarded to Mr. H. Rogers, for conspicuous services, especially in connexion with education and research. The presentations were made at the annual dinner of the Institution, held in Manchester on December 10. It is of interest to note that Dr. Parkinson was originally a geologist, and is known for his work on Lower Carboniferous stratigraphy in Lancashire and Yorkshire, which he is continuing; he is also engaged in biometrical studies of brachiopods from the reef limestones of these areas.

Pollution of the River Thames

On December 15 the Minister of Housing and Local Government, Mr. H. Macmillan, made the following written statement, afterwards circulated, in reply to a question in the House of Commons on research into the pollution of the River Thames: "The extensive research still in progress covers such things as the quantities, temperature, and chemical and biological condition, at various points and times, of the estuary water itself and of the discharges into it from the upper Thames, tributaries, sewage works, and industrial premises (including gas works and power stations); the nature and behaviour of bottom mud and suspended solids; the volume and movement of liquid within the estuary; and the interactions of these and other factors, in varying conditions, as affecting—among other things—the production, oxidation, solution, and release, of hydrogen sulphide. Much of it is fundamental research now being undertaken for the first time, and the results should be of considerable use in relation not only to the Thames but also to other estuaries . . . it is already accepted that a major cause of the complaints in the lower reaches of the Thames is the need to improve the purification of London's sewage, and the London County Council, who have long been anxious to carry out the necessary works, have now been authorised to do so".

Higher Technological Education in Great Britain

In reply to a question in the House of Commons on December 15, regarding the Government's plans for the development of higher technological education in Great Britain, Mr. R. A. Butler said that these plans would afford improved facilities for both postgraduate and undergraduate students, and he expected that the universities and colleges concerned, the schools and industry would all play their part in the measures required to encourage an increased flow

of students. The Minister of Education and the local education authorities could also assist, and he recognized the importance of developing technical education prior to higher technological education.

Biology as a Career

A most useful booklet to all those contemplating a career in biology has been produced by the Institute of Biology. Besides assessing the qualities desirable in a biologist, the booklet contains useful information about the training required for various posts. The most valuable feature of the booklet, however, is the section describing opportunities open to professional biologists in schools, universities and other educational institutions, medical research, agriculture and horticulture, hydrobiology and fisheries, forestry, the Nature Conservancy, the Scientific Civil Service and industry; careers in the British Commonwealth and the Colonies are included. The present and future supply and demand for biologists are also examined and show that, although it is becoming increasingly difficult for less well-qualified biologists to find posts suitable to their qualifications, there is an acute shortage of persons to fill the more responsible positions. Details are provided of the rates of pay of biologists in schools and technical colleges, the universities, the Scientific Civil Service, the Colonial Research Service and industry.

Elementary Meteorology for Young People

The most recent of a series of popular lectures promoted by the Royal Meteorological Society was given at the Royal Institution by Mr. J. S. Sawyer on December 2 to an audience consisting almost entirely of pupils from forty-seven London secondary schools. Mr. Sawyer gave a well-illustrated lecture on weather forecasting, in which he traced the development of modern techniques from primitive weather lore to the use of *radiosonde* upper-air soundings over land and sea. He described the intricate communication system necessary for a modern forecasting unit and showed in remarkably clear terms how new methods of upper-air analysis are opening the way to longer-range weather forecasting. A brief glimpse into the future indicated that electronic computors would help to deal with the mass of data in the short time available to those preparing a weather forecast. At the end of the lecture, the pupils put questions which were most intelligent and clear, and must have been very satisfying to the teachers present. In view of its popularity, the lecture will be given again on February 4 at 5.30 p.m. in the L.C.C. Lecture Rooms, County Hall, Westminster, London.

Gynospore or Megaspore ?

When the terms 'megaspore' and 'microspore' are used in relation to the life-cycle of seed plants, most botanists would understand that a typical heterosporous ancestry for seed plants was implied. But does this terminology faithfully represent the facts ? In a recent study, J. Doyle ("Gynospore or Megaspore—a Restatement", *Ann. Bot.*, N.S., **17**, 67, 466; 1953) points out that, in measurements of spore size in gymnosperms, the two spore types are found to be at least sub-equal, and that in conifers the pollen or microspore may actually be larger than the megaspore. *Sequoia sempervirens* is cited as an example of a living species which shows "a direct transition to the seed condition from what is essentially a homosporous condition". Since, in the author's view, seed origin from homosporous sources cannot be ruled out on the existing evidence, the terms 'gynospore' and 'androspore' may be preferable to those now in general use.

Carbon Dioxide Fixation by Roots

Many non-green plant and animal tissues are able to assimilate carbon dioxide. Using carbon-14 dioxide and radiochromatography, L. W. Poel (*J. Exp. Bot.*, **4**, 11, 155; 1953) has investigated the fixation of carbon dioxide by excised barley roots, the non-volatile ethanol-soluble products of fixation being determined. The main radioactive compounds separated were malic, citric (or *iso*-citric), aspartic, and glutamic acids, and asparagine and glutamine. Less activity was present in serine, tyrosine, α-ketoglutaric acid and alanine, and in a number of unidentified compounds. Anaerobic conditions inhibited the uptake of carbon-14 dioxide. The results obtained lead to the conclusion that carbon-14 is probably transformed through the reactions of the tricarboxylic acid cycle.

Gifts of Rock Paintings to the National Museum of Wales

An interesting and munificent gift to the National Museum of Wales of forty-five drawings made in quarries and sheds where quarry products are prepared for the market is described by Dr. F. J. North in the November issue of the *Museums Journal*. The drawings were given by an artist, Miss M. E. Thompson, and constitute an interesting record of contemporary conditions in some of the slate and stone quarries of North Wales and in the Portland quarries in Dorset. Miss Thompson has been outstandingly successful in reproducing the atmosphere of quarries, and her drawings are works of art in addition to being realistic representations of the rocks. She has been equally successful in gaining the confidence of the quarrymen and thus was able to show the work in the mills and even studies of the men themselves. The drawings will do much to illustrate rocks and scenery, and help the public to an appreciation of the beautiful in Nature.

Canadian Journal of Microbiology: Forthcoming Publication

The National Research Council of Canada proposes to start a new publication, the *Canadian Journal of Microbiology*, commencing in August, with subsequent numbers every two months. Dr. R. G. E. Murray, of the Department of Bacteriology, University of Western Ontario, has been appointed editor. The *Journal* will consider for publication scientific papers describing original research in all phases of microbiology, regardless of country of origin; papers will be published in either English or French. Reviews will not be accepted. For publication in the first issue, manuscripts should be submitted by April 1, and in this connexion the general instructions to authors given in recent issues of the *Canadian Journal of Botany* should be followed. The subscription rate for the new journal is 3 dollars a volume. Inquiries should be sent to the Accounts Officer, National Research Council, Sussex Street, Ottawa 2.

Methods of Recording Sound

An international meeting on "Methods of Sound Recording and their Applications in Different Fields" will be held in Paris during April 5–10, 1954. The

congress, which is being organized by the Société des Radioélectriciens, will be divided into four sections: mechanical recording; photographic recording; magnetic recording; and development and standardization problems. An exhibition, comprising both the latest types of apparatus and instruments of historical interest, will be held at the same time. It is hoped that the meeting will be widely supported by specialists in these topics from many countries. Further information can be obtained from the Société des Radioélectriciens, 10 Avenue Pierre Larousse, Malakoff, Seine.

The Rationalized Metre–Kilogram–Second System : Courses in Bristol

The Regional Council for Further Education for the South West, in collaboration with Bristol Education Committee, is organizing two short courses on the Rationalized Metre–Kilogram–Second System, designed for teachers of physics and engineering in universities, technical colleges and grammar and public schools, and for engineers and physicists in industry and others interested in problems of electrical measurement. One of the courses will be part-time, being planned for those who live within easy travelling distance of Bristol, and will be held at the College of Technology, Bristol, on six evenings, Mondays and Wednesdays of the weeks beginning April 26, May 3 and May 10, 1954, from 6.30 to 9 p.m. The other course will be full-time and residential and will be held at Wills Hall, Stoke Bishop, Bristol 9, during the week-end April 2–4, 1954. The fee for either course will be £1 1*s*. with a residence charge of approximately £2 15*s*. for the full-time one. Further information can be obtained from the Secretary, Regional Council for Further Education for the South West, 12 Lower Castle Street, Bristol 1.

University of London : Appointments

Prof. A. D. Young, professor of aerodynamics in the College of Aeronautics, Cranfield (see *Nature*, 165, 220; 1950), has been appointed to the University chair of aeronautical engineering tenable at Queen Mary College, London, in succession to the late Prof. N. A. V. Piercy. The title of professor of veterinary bacteriology in the University has been conferred on Dr. Reginald Lovell, in respect of the post held by him at the Royal Veterinary College, and the title of professor in experimental biochemistry in the University on Dr. C. J. O. R. Morris, in respect of the post held by him at the London Hospital Medical College. The title of reader has been conferred upon the following in respect of the posts held by them in the subjects as indicated: Dr. J. A. Barnes, anthropology at the London School of Economics and Political Science; Mr. A. J. Arkell, Egyptian archæology at University College; Dr. Tom Barnard, micropalæontology at University College; Dr. W. R. Mead, geography at University College; Dr. Ruth L. Saw, philosophy at Birkbeck College; Dr. J. O. Wisdom, logic and scientific method at the London School of Economics and Political Science.

Announcements

Mr. W. H. Langmaid has been appointed assistant comptroller in the Patent Office to take charge of the Trade Marks Branch in succession to Mr. S. E. Chisholm, who has retired. Mr. Langmaid joined the Patent Office as an assistant examiner in 1921, and he has served continuously in progressive ranks except for a short break during the Second World War. He is a Whitworth Scholar and was educated at the Royal Naval College, Greenwich. He was called to the Bar at the Middle Temple in 1926. His recent service in the Patent Office prior to his present appointment was as superintending examiner in charge of the section dealing with applications for prolongations of the term of patents, based on war-time restrictions on the patentee.

Dr. Maurice M. Shapiro, head of the Cosmic Ray Branch in the Naval Research Laboratory, Washington, D.C., has been appointed superintendent of the Nucleonics Division of the Laboratory, in succession to Dr. F. N. D. Kurie, who has become technical director of the United States Navy Electronics Laboratory in San Diego. The Nucleonics Division is one of twelve scientific divisions at the Laboratory and is concerned with fundamental and applied research in nuclear physics. Dr. Shapiro will continue to be in charge of cosmic ray research at the Laboratory.

Mr. C. W. Strutt will be returning to the United Kingdom on March 26 after a five-year tour of duty as agricultural adviser to the High Commissioner to the United Kingdom in Australia, and will be succeeded by Mr. Thomas Cross Creyke. Mr. Creyke, who studied agriculture at the University of Leeds and dairying at the West of Scotland Agricultural College, has been county agricultural officer first to the Lancashire, and then to the Yorkshire (North Riding), Agricultural Executive Committees since 1944. In 1952 he undertook a dairy survey in Italy on behalf of the United Nations Food and Agriculture Organization.

The Mond Nickel Fellowships for 1953 have been awarded to the following for study in the United Kingdom, on the Continent of Europe and in the United States and Canada on the topics indicated: J. E. Benson (Metropolitan-Vickers Electrical Co., Ltd., Manchester), the technique and interpretation of results of non-destructive testing of metal components; K. Blackburn (Dorman, Long and Co., Ltd., Redcar), hot-metal basic open-hearth practice, with particular reference to mixer furnace operation, refractories, instrumentation and pitside practice; N. B. Pratt (Broken Hill Proprietary Co., Ltd., Newcastle, New South Wales), the technical and economic aspects of recent advances in the erection and operation of integrated iron and steel works.

The Langley Memorial Prize, of value approximately £17, is open to competition among officers of the Colonial Medical Service who are serving, or who have served, in West Africa, and will be awarded for the best paper on one of the following subjects: tropical medicine or surgery; tropical hygiene and sanitation; and tropical entomology and parasitology. Papers, which may consist of either published or unpublished work, should be sent to the Dean, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, not later than October 1.

In the article "Fuel Problems in Britain" in *Nature* of December 26, reference is made to the recent Melchett Lecture to the Institute of Fuel as having been given by Sir Harold Hartley; this Lecture was delivered by Dr. Harold Hartley, chairman of directors of Radiation, Ltd.

RESEARCH AND SCIENTIFIC SERVICES IN EAST AFRICA

A SURVEY of the organization of the inter-territorial research and scientific services in Kenya, Uganda, Tanganyika and Zanzibar, particularly those which are responsible to the East Africa High Commission, was completed by Dr. E. B. Worthington in December 1951 while serving under the Administrator to the High Commission and before he was appointed secretary-general of the Scientific Council for Africa South of the Sahara. The work has now been published under the title of "Survey of Research and Scientific Services in East Africa, 1947–1956"*. Besides describing developments up to the end of 1951, it records Dr. Worthington's views as to how these services should be developed during the next five years within the limited financial provision which is foreseeable to-day. The account is, in fact, both a report on four years of progress and a revision of the development plan outlined in Dr. Worthington's unpublished report of January 1948.

Although finance is a dominating factor in determining how much scientific work can be undertaken, the four references to finance are in general terms and of such a nature as to enhance the importance of the publication of the survey at this juncture. It directs attention to matters which require careful consideration in connexion with the proposals now under active consideration for the further extension of funds for research under the Colonial Development and Welfare Acts. Moreover, it indicates considerations which bear closely on research and scientific services not only in East Africa but also in other territories receiving technical and scientific assistance, whether under the Colombo Plan or the Expanded Programme for Technical Assistance of the United Nations.

Dr. Worthington makes no exaggerated claims for the planning of scientific work, nor does he imply that research is susceptible of detailed planning many years in advance. It is possible and necessary, however, to plan well ahead for the provision of facilities and staff, and to indicate broad problems to which solutions are required. Such planning is, in fact, an essential element in producing the scientific and administrative climate in which research flourishes —a climate of confidence. Where Dr. Worthington leans to regional organization, it is for the sake of the continuity and stability which are indispensable if confidence is to be engendered. The full weight of his authority can be put behind the pleas which have been made for continuity and greater assurance in the support of the Technical Assistance Programme. "Research which is subject to the hazard of interruption on financial ground cannot be fully productive," he writes, and pointing out that many forms of research need to be planned as much as ten years ahead, he emphasizes the importance of fresh provision being made by Parliament for Colonial research well before the expiry of the existing Acts. His argument is enforced by the observations which Dr. Worthington makes on regional organization of science as against a territorial basis. These advantages, such as the ability to view the technical problems of the territories as a whole, the means to afford a large staff of specialists and consequent greater confluence of thought on a single problem, and the greater attractiveness to first-class scientists and scientific visitors, will be seriously affected by uncertainty as to future resources. For the present, however, while the territorial Governments themselves are separate, most of the executive side of scientific work will continue to be arranged territorially and the regional scientific services to be limited to advisory functions and the investigations necessary as a basis for advice.

Dr. Worthington gives a summary of the East Africa Regional Scientific Services during 1952, which employed 151 professional officers with a recurrent expenditure of just under £750,000. Of this, a little more than £100,000 each was expended on meteorology, on agriculture, on the tsetse flies and trypanosomiasis organization, and on health and medicine, just over £50,000 on fisheries, a little less on animal health, and £60,000 on statistics. Only in agriculture and forestry, in health and medicine and in the tsetse flies and trypanosomiasis organization were more than twenty professional officers employed, and Dr. Worthington directs attention to the wide range in the average cost of supporting a professional officer, including his assistants, facilities and all overheads. Due to the differences in type and conditions of work, this may vary from less than £2,000 per officer in sociology to more than £10,000 in meteorology and the desert locust survey, and accordingly the efficiency of a research organization cannot be judged merely by its cost per scientist.

These observations are pertinent not only for the services organized under the East Africa High Commission and the territorial services with which they are related, but also for the organizations and agencies concerned with scientific work elsewhere in Africa, with which the exchange of knowledge, and even closer relations, is of increasing importance. Dr. Worthington reviews briefly these relations, and glances also at the arrangements by which technical and scientific assistance is received from the United States and at the relations between the work in East Africa and the Colonial Office and scientific work in the United Kingdom. The clear picture he gives of all these relations and of their implications is of value to all concerned with such work, but to scientists in general the major interest of his survey will be the review he gives of the current position of the principal fields of scientific investigation in East Africa and his estimate of the future needs in each of these fields. As a background to this review he gives a tabular summary showing the services which at present function in these fields, the administering authorities and the sources from which they are financed.

Considering first the subject of surveys and maps, Dr. Worthington concludes that the full needs of East Africa are unlikely to be met by the publication of atlases and maps already in preparation, and that, following the international geological and tsetse fly maps of Africa, a standard scale of 1 : 5,000,000 is probably the best for initial purposes to illustrate

* East African High Commission. A Survey of Research and Scientific Services in East Africa 1947–1956. (Paper No. 6.) By E. B. Worthington. Pp. iii+79. (Nairobi: East African High Commission, n.d.)

other subjects. During the next few years the object should be to publish adequate special subject maps, either for East Africa as a whole or for each territory separately, with larger scales for Uganda and Zanzibar. Most of the consultation involved in collecting, analysing and presenting the necessary data could be secured by giving adequate financial assistance to the Geographical Department of Makerere, with close contact with the Central Directorate of Colonial Surveys and the Territorial Survey Departments.

In regard to geology and archæology, Dr. Worthington considers that even with the aid already received from the United States under the Economic Co-operation Assistance Administration, the individual territories are unlikely ever to be able to afford a geological survey large enough to be truly efficient. No adequate provision yet exists for archæology, and apart from the importance of the subject to culture in general, and the value of the archæological wealth to the tourist industry, Dr. Worthington points out that research in this field is desirable because of the importance of Tertiary and Quaternary geology in connexion with water supplies and mineral resources. The projects advanced during 1944–48 for a full-scale inter-territorial archæological survey are at present in abeyance, and Dr. Worthington urges that several young archæologists should be set to work in East Africa while the guidance of specialists of international reputation is still available.

In meteorology, heavy routine duties have precluded much research by the East African Meteorological Department, but a wide range of research is desirable, particularly where meteorology impinges on questions of water supply, agriculture and health: recent work has indicated, for example, that the fundamental study of air masses is likely to be of the utmost importance in connexion with the problem of the desert locust. Water supply and agricultural interests have strongly supported the formation of a small climatological research section. The importance to East Africa of adding a rainfall research unit to the Meteorological Department can scarcely be overstressed, and the growing importance of hydrology and of relating it to climatic conditions has already led to proposals for an inter-territorial hydrological bureau.

In regard to background biology, Dr. Worthington suggests that three steps are desirable for dealing with the difficult situation in systematic entomology. First, a building for systematic entomology should be erected in the Coryndon Museum grounds, similar in design to the East African Herbarium, in which should be pooled all major collections of insects and related groups. Secondly, the building would be staffed with the entomologists from the Coryndon Museum and other entomologists working on systematics recruited to the inter-territorial research organizations. Thirdly, the Colonial Office might consider a scheme for entomology similar to that already made for the flora. The appointment of a mammalian zoologist to the Coryndon Museum is considered to be of high priority, and in marine and freshwater zoology there is almost unlimited scope for studies in background biology and systematics.

The East African Agriculture and Forestry Research Organization is the largest body of this character in East Africa and has completed its first phase of development; nevertheless, with a total of twenty-seven scientific staff it is far short of the thirty-five which were to be recruited by 1952. It seems probable that it will only be increased to thirty-two or thirty-three by 1955 instead of to the forty-five originally envisaged as the minimum for a balanced research programme. During the remainder of the period of Colonial Development and Welfare Funds, up to March 1956, the Organization will accordingly have to concentrate on soil science (including microbiology of soils), on plant pathology and on animal husbandry, with a few officers on forestry problems; the original plans for work on plant breeding and entomology will have to be deferred. The Organization is in close touch with the East African Veterinary Research Organization, the new headquarters of which since September 1953 are also at Muguga South, with main laboratory and field-work at Muguga North. When all the latter facilities are available, the staff is expected to increase from the ten scientific officers and thirteen European assistants of 1952 to twenty scientific officers and twenty-five European technical and administrative officers. Together the establishments at Muguga North and South will then constitute one of the largest scientific centres in Africa.

Dr. Worthington notes the work being carried out by the East African Tsetse Flies and Trypanosomiasis Research Organization; by the Desert Locust Survey, stressing the importance of allowing research work by this body to proceed unimpeded by concentration on control measures; and by the Colonial Insecticides Unit. Under problems concerned with the control and conservation of wild animals, he supports two proposals from the Game Sub-Committee set up by the Colonial Office as being of inter-territorial, if not international, significance. A research team, consisting of a biologist, a veterinary research officer, a botanical ecologist and a game ranger, should be recruited to investigate and collect information on game problems in one area, for example, Tanganyika, to supervise the practical work involved in setting up experimental game fences and to undertake research into game management. A survey should also be made of all information available on scientific questions relating to the mammalian fauna of East Africa. A worker has already been appointed to make this survey; but, although details for a research unit for the first project were worked out towards the end of 1951, the East African Governments, while expressing interest, withdrew financial support.

In fisheries research the chief need of the inter-territorial marine fishery research unit at Zanzibar is for the larger research vessel, properly equipped for marine research, contemplated in the original plans. In freshwater fishery the Lake Victoria Fisheries Service is only now starting to introduce and administer inter-territorial legislation designed to assist the development of the industry and the conservation of stocks; the third or technological phase will be to introduce new or improved methods of fishing, to tap new resources and to organize better methods of preserving fish and of marketing and distribution. Up to now the East African Industrial Research Board has been financed by the East African Governments without grants from Colonial Development and Welfare Funds, although Tanganyika withdrew in 1947 when its own government chemical laboratory was enlarged, and pending the establishment of an East African Industrial Research Organization. Although a Director of East African Industrial Research was appointed in April 1951, details of the new organization and the method of financing it are not yet finally settled. Present proposals contemplate four units, of some five or six

scientists each, for chemistry and chemical engineering, for building research, for road research and for metallurgical work: the first, with the directorate, and the second would be in Nairobi, the third in Tanganyika and the fourth in Uganda.

Reviewing inter-territorial research in health and medicine, which is organized in several independent units or institutes, each separately responsible to the Administrator of the High Commission, with the East African Bureau of Research in Medicine and Hygiene as co-ordinating agency, Dr. Worthington suggests that the East Africa Medical Survey may in the future either turn its primary concern from investigation to the application of the results, or hand over application to the territorial departments and extend its investigations to other African areas for comparison with work now being conducted in Sukumaland. If the Filariasis Research Unit terminates in 1954, its facilities will presumably be absorbed into those of the Medical Survey, but the Malaria Unit should continue, if not expand, and the Virus Research Unit at Entebbe likewise has a great field of research open to it. Future planning, however, while depending on the results of the Medical Survey, should be designed particularly towards the development of preventive techniques, but should include provision for fuller investigation on an inter-territorial basis of such problems as nutrition, schistosomiasis, snail vectors, silicosis, tuberculosis and plague, and especially the effect upon the numbers, activity and output of a population of large-scale measures for control of disease. This matter is closely related to the demographic studies of the East African Statistical Department, and Dr. Worthington suggests that the possibility of creating an "operational research unit" to assess the interaction of all factors on the general economy of East Africa should be kept in mind. The East African Institute of Social Research and research workers connected with it are at present devoting special attention to the study of the development of local government in African societies. Dr. Worthington directs attention to the need for good libraries and information services, with which East African science is not yet well equipped; but though he advocates a publicity policy in which due regard is paid to the comparative responsibilities of regional services as compared with territorial departments, he suggests that in East Africa it is better to concentrate on enlarging and improving the existing scientific or technical periodicals than to establish new ones.

Dr. Worthington's most important references to finance are to be found in his final section, which includes a tabular summary forecast of East African Regional Scientific Services in 1956. Recurrent expenditure is put at no more than £868,000, with some 182 professional officers, meteorology (£120,000) and tsetse flies and trypanosomiasis (£118,000) being the largest items, while on four others—agriculture and forestry, animal health, locust survey, and health and medicine—expenditure is a little above or below £100,000. This represents an increase of 17 per cent in four years, in accordance with a period of consolidation, rather than of expansion, and one in which the proportion of total effort devoted to research on the productive services has increased slightly with reduction elsewhere. Moreover, expenditure in East Africa represents about one-third of the Colonial Development and Welfare Research Funds already committed, although the region represents only about one-fifth of the Colonial Empire. Dr. Worthington recognizes that the solution of major problems during the next five years or so may permit some readjustments, for example, possibly a reduction in the size of the Tsetse Flies and Trypanosomiasis Organization; but although the East African Governments may be expected to increase their expenditure on research, the percentage of expenditure on research in their rapidly expanding budgets is unlikely to exceed the present three per cent. Continuing support from Colonial Development and Welfare Research Funds will be required, and finally Dr. Worthington pleads that, in the future organization and finance of research in East Africa, regard should be had to the academic system of picking really good men and giving them full freedom of action.

WEIZMANN MEMORIAL CONVOCATION

TO mark the first anniversary of the death of the late President Weizmann, a number of events of scientific interest took place at the Weizmann Institute of Science at Rehovoth, Israel. On November 3, the new building of the Department of Experimental Biology was formally opened (p. 68), and at the same time the corner-stone of the Institute of Physics laid. On the afternoon of the same day, honorary fellowships of the Weizmann Institute were conferred upon the following guests: Prof. Niels Bohr (Copenhagen), Dr. Ernst E. Chain (Rome), Dr. Herman F. Mark (Brooklyn), Prof. Linus C. Pauling (Pasadena) and Dr. F. Peyton Rous (New York). Following this ceremony, Prof. Niels Bohr gave an address on "Modern Physics and Philosophy".

The occasion was taken to hold a number of scientific symposia. In a biological symposium, Dr. Peyton Rous gave a general account of the "Natural History of Cancer", Prof. I. Berenblum (Rehovoth) spoke on the mechanism of carcinogenesis, Dr. M. Shelesnyak (Rehovoth) spoke on recent work on the mechanism of nidation in the mammalian uterus, and Dr. L. Sachs (Rehovoth) presented a genetical analysis of evolution.

In a symposium on polymers and proteins, Prof. Mark described recent developments in the study of block copolymers; Prof. A. Katchalsky (Rehovoth) gave an account of the rheological properties of polyelectrolyte gels and Prof. Pauling spoke on the α-helix structure of protein.

There was a symposium on microbiology and biochemistry in which Prof. Chain described the role of insulin and other substances in glycogen formation; Prof. E. Katchalsky (Rehovoth) spoke on the polymerization accompanying the action of proteolytic enzymes on poly-α-amino-acids, and Dr. S. Hestrin (Jerusalem) on the synthesis and degradation of polysaccharides.

In the physical symposium, Prof. Niels Bohr gave a general introduction to modern atomic physics (electronic and nuclear) and its relation to molecular structure questions; Dr. A. Bohr (Copenhagen) described recent results, both theoretical and experimental, on nuclear rotational levels; and Prof. G. Racah (Jerusalem) spoke on angular correlation between nuclear radiation. Dr. S. Rozental (Copenhagen) wound up the symposium with an account of the organization and work of the Institute of Theoretical Physics in Copenhagen.

Apart from these symposia, Prof. Pauling gave two separate lectures—one on a new approach to the problem of ferromagnetism and the other on the connexion between various blood-cell diseases and structural changes in the hæmoglobin molecule. Prof. Mark also lectured, with interesting demonstrations, on new types of synthetic polymers.

The Memorial Convocation ended in December with a series of lectures by Sir Robert Robinson on "Structural Relations in Natural Compounds"; these constitute the first set of Weizmann Memorial Lectures, which, it is intended, will become an annual event.

EXPERIMENTAL BIOLOGY AT THE WEIZMANN INSTITUTE OF SCIENCE, REHOVOTH, ISRAEL

THE official opening of the Isaac Wolfson Building for Experimental Biology on November 3 represents the completion of a further stage in the development and expansion programme of the Weizmann Institute of Science in Rehovoth.

The Weizmann Institute of Science, which grew out of the former Daniel Sieff Research Institute of Organic Chemistry and Microbiology, began its first stage of expansion in 1948, with the creation of new departments for applied mathematics, optics, isotope research, biophysics and high-polymer research. At that time, plans were already being made for a further extension towards the ultimate creation of an Institute of Biological and Medical Sciences, of which the present Wolfson Building is a first stage, to accommodate the Department of Experimental Biology.

The new building is an attractive, four-story structure, of about 500 square yards per floor. It is air-conditioned, with a lift, broad corridors and other amenities suitable for animal work. It includes ten laboratories, eight animal rooms, three rooms for cleaning and sterilizing of cages, an operating unit, a library, a seminar room, a photographic unit, and storage rooms. The internal construction is of a somewhat flexible design, for easy convertibility from laboratory to animal room, etc.

The Department of Experimental Biology is under the direction of Dr. I. Berenblum, formerly of the Sir William Dunn School of Pathology, University of Oxford. The major field of research in the Department is on cancer, with special emphasis on the mechanism of carcinogenesis. Included in the Department are separate units on endocrinology and cellular genetics; it is hoped to include, in time, further units, for example, on pharmacology, experimental embryology, and basic nutritional research. The experimental animals, including several genetically inbred strains of mice, as well as rats, rabbits, guinea pigs and hamsters, are all bred on the premises, and additional facilities are available close by for outdoor breeding of the larger animals, with suitable runways, etc.

The Weizmann Institute of Science is, at the moment, engaged in planning a post-doctoral school, towards which the new developments in biological sciences will have much to contribute.

Isaac Wolfson Building, Weizmann Institute of Science, Rehovoth. Copyright Schleisner Rechovo

EFFECT OF FLOODS ON THE OYSTER GROUNDS OF EASTERN BRITAIN

By G. DUNCAN WAUGH

Fisheries Laboratory, Burnham-on-Crouch, Essex

ALL the oyster-producing grounds of the east coast of Britain were within the area affected by the floods of January 1953, and in many cases the damage done was considerable. In Essex, where the major losses occurred, oyster cultivation is carried on in the estuaries of the Rivers Colne, Blackwater, Crouch and Roach, and in the numerous creeks which enter these rivers. Many of these creeks are in reality embanked inlets in the marshes. Where the banks were broken, immediate and serious damage occurred on the adjacent oyster beds.

There were two main causes of loss: first, the burying of the oysters on the creek bottoms under debris from the land, and, secondly, the choking of the oysters in the rivers and creeks by the great quantities of silt present in suspension in the water. Damage of the first type usually occurred on oyster grounds which adjoined major breaches in the sea wall; for example, a big breach was made in the wall above Old Hall Marshes, near West Mersea, on the north side of the River Blackwater, and the oyster grounds in the upper part adjoining Tollesbury Fleet suffered severely. Surveys made soon after the floods showed that there was a thick layer of debris consisting of mud, turves, stalks and leaves of *Spartina townsendii*, etc., covering the oyster beds. A great deal of this material was putrefying. The work involved

in clearing this from the grounds was considerable and, before favourable conditions could be restored, many oysters had been lost.

The second type of damage, resulting in the death of the oysters, can be illustrated by referring to conditions in the River Roach. In one stretch beside Paglesham, where there were no very serious breaches, mortalities were exceptionally high—of the order of 40 per cent. There was no evidence of smothering of the grounds, but dying oysters were observed to have their gills choked by fine silt. The silt was so light that it remained in suspension for a considerable period and, indeed, the water in this area, and others nearby, was observed to be heavily discoloured for more than three weeks after the disaster. The bulk of the silt lying on the bottom was so light as to sift through the oyster dredges as they were being worked; thus no indication of smothering was seen when the dredges were lifted. The shores above low-water mark were often covered by a thick layer of fine silt and the water at the edge of the tide was extremely turbid.

The breaches which were mainly responsible for producing this silt occurred lower down the River Roach along the banks of Wallasey Island; but here the oysters suffered less, total mortalities being approximately 25 per cent. In Yoke Fleet, a creek off the River Roach, bordering the south side of Foulness Island, where a breach occurred, mortalities were as high as 80 per cent; but again there was little evidence of smothering of the grounds, and suspended silt must be held to have been responsible for a large proportion of the loss.

On the south side of the Thames the only large oyster industry is at Whitstable, where conditions differ substantially from those in Essex, described above. The oyster beds are situated on a gently shelving bottom and extend several miles offshore. Damage was far less severe than in the Essex creeks, and there was little evidence of smothering of the grounds by debris from the land. However, the waters of the Thames estuary and the River Swale were extremely turbid. Many dying oysters contained an abnormal amount of silt, and that, combined with the churning action of the waves on the shores fully exposed to the north-east gales, probably accounted for much of the loss that did occur.

A notable feature of the effects of the flood was the differential mortality that occurred among native oysters, *Ostrea edulis*, and Portuguese oysters, *Gryphaea angulata*. It has been suggested on many occasions that oysters of the genus *Gryphaea* are better adapted to living in turbid conditions by virtue of their possession of an additional pro-myal chamber in the mantle. Certainly, where there was no actual smothering of grounds, the Portuguese oysters survived, though the natives died.

Not all the losses which occurred on the grounds could be attributed to the floods. Generally speaking, the east coast oysters were not in such good condition as in previous years, and the winter, though not exceptionally cold, was prolonged. Water temperatures remained at, or below, 5° C. in the River Roach for more than five weeks longer than during the winter of 1951–52. It was to be expected, therefore, that the natural mortality would be greater than normal.

Regular surveys of oyster mortalities in the Rivers Roach and Crouch have been made during the past four years, and it was therefore possible to estimate approximately what the seasonal losses would have been had the floods not occurred. Further, heavy mortalities observed after the floods were often localized, so that, for example, in Tollesbury Fleet, an area associated with a break, mortalities were of the order of 25–30 per cent, whereas in the adjoining Salcott Creek they were between 10 and 15 per cent. Provided that other environmental factors were equal, it was evidence of this type which tended to confirm that excessive mortalities were, in fact, due to the effects of the flood.

Apart from the immediate damage resulting from the floods, it is possible that there may have been more prolonged effects. Usually the greatest proportion of oysters which are weak do not die until the water temperature begins to rise; in consequence, the winter mortality does not become fully apparent until about the beginning of April. There were many reports of a continued mortality throughout the summer of 1953, but it was not possible to ascribe these to floods alone. It is possible, however, that the increased quantity of silt in the water produced some long-term effect; but, at the most, it can only be regarded as one of a complex of environmental factors, all of which could have contributed to the later mortalities.

PRODUCTIVITY IN HOUSE-BUILDING

THE Building Research Station has made a survey of 177 housing contracts completed between March 1949 and March 1951 and has published its findings in a report, the second of this nature, entitled "Productivity in House-Building"*. The report covers the man-hours and labour cost expended by the main contractor and sub-contractor, any conditions, such as the nature of the site and type of incentive scheme, which might be expected to influence them, and the size and form of construction of the house; and it confirms the low average level of productivity compared with estimates of pre-war performance, and the great variations in the labour required on different contracts for the same work. Productivity was high in relation to the average on contracts with incentive schemes, on contracts directly supervised by the main contractor, and where the contractor was experienced in house-building. There was a small but consistent decrease in productivity throughout the period. The regional differences in the man-hours per house decreased as the size of the contract increased. Sub-contractors and main contractors on work in the same trade differed significantly in productivity.

For high productivity three factors appear to be of crucial importance: good supervision, incentive schemes and efficient organization of the work on the site. The importance of good supervision is shown by the high productivity of the "Working Principal" sub-contractors and of the small main contractors who directly supervised the work on the site. These achieved as good results as the larger contractors obtained with target bonus schemes, and this indicates not only the value of close supervision but also the importance of a financial incentive to the supervisor.

* Department of Scientific and Industrial Research. National Building Series. Special Report No. 21: Productivity in House-Building. Second Report. (Building Research Station.) Pp. iv+38. (London: H.M. Stationery Office, 1953.) 1s. 9d. net.

With regard to operatives, there was evidence that incentives had effected a reduction of about 15 per cent in man-hours per house and such incentives are of particular value on large sites on which adequate supervision is difficult. Efficient organization of the work on the site offers economies in overhead charges as well as in labour cost, and in the trade of bricklayer substantial savings of labour cost were achieved on large contracts; but the advantage tended to be lost in the remaining trades in the absence of preplanning of the work. The report indicates some common features in contracts of high productivity, the wider application of which might effect a substantial decrease in the average expenditure of labour.

TEMPERATURE AND RATE OF ENZYME ACTION

By Dr. JAN BELEHRADEK

19 Av. Kléber, Paris 16

THE temperature-rate relation of enzyme activity continues to be discussed, and several modifications of the basic Arrhenius equation have been proposed together with various theoretical implications. The modification suggested by Eyring[1] for rate processes in general represents the most elaborate among the formulæ so far put forward; it includes no less than eleven constants for the two variables. For enzymological purposes the formula can be used in a simplified form, as some of the less relevant terms can be eliminated; but then more than one numerical value of the activation energy will often be found for one and the same enzyme, especially if the range of experimental temperatures is sufficiently wide. For this and other reasons, application of the theories attached to the formula and its modifications seems to present difficulties to enzymologists.

It is well known that the plot of log rate *versus* $1/T_{abs.}$ often gives a curve instead of a straight line, as required by the simple collision theory, and in the case of enzyme reactions the discrepancy is rather large. In order to make the graph linear, additional constants have to be introduced with various theoretical meanings. It is on this point that opinions vary most; in particular, the 'breaks' often observed in the graphs, instead of a smooth curve, have not yet received satisfactory explanation.

The most likely explanation seems to be that they are mathematical artefacts analogous to those seen in biological applications of the same law[2,4]. Caution is the more necessary since the same set of data will often give a straight line when represented by a different and relatively simple rate-temperature ratio, namely, when log rate is plotted against log temperature, the latter being expressed in centigrade degrees and reckoned not from 0° C. or 0° K., but from a specific zero point to be determined for each given enzyme. If this specific thermal zero is denoted as α, the rate k depends on temperature t thus:

$$\log\left(\frac{k_2}{k_1}\right) = b.\log\left(\frac{t_2 - \alpha}{t_1 - \alpha}\right).$$

The factor b is a constant with the significance of a temperature coefficient; being the tangent of the angle which determines the steepness of the line, it indicates the extent of the influence exerted by temperature upon the rate. Thus two constants suffice to define the relation between the two variables. It must be admitted, however, that computation of α is not a simple mathematical operation.

The formula was originally proposed by me in 1926[5] for temperature-velocity studies of biological processes. In reviewing the field now again for other purposes, I applied the formula to enzymes, and found that it describes satisfactorily many experimental data on enzyme kinetics, and that the instances where it fits are not exceptional or incidental (see Fig. 1).

In using the equation for biological purposes, b is connected with the degree of resistance opposing free movements of molecules in various protoplasmic phases in which the underlying metabolic processes take place; and α is the temperature threshold below which molecular displacement connected with a given biochemical process is blocked by cold owing to a critically enhanced resistance. If the same scheme could be applied on the enzyme level of the cytochemical mechanism, and also to isolated enzymes, the theoretical meaning of α might be that of a temperature, at which the molecular configuration becomes, by reason of cold, so rigid as to prevent the substrate molecules, the kinetic energy of which too has been diminished by cold, from attaining freely the catalytically active spot. Only when the enzyme molecule is sufficiently heated will the thermal agitation of its atoms and atomic groups make it possible for the substrate molecules to travel with necessary speed across the fields of its configurational pattern. It is possible that in cold the number of inner hydrogen bridges increases for thermochemical reasons, analogous to those owing to which the hydrogen bridges diminish in number on denaturing by heat; then the enzyme molecule would be catalytically inactive not only when

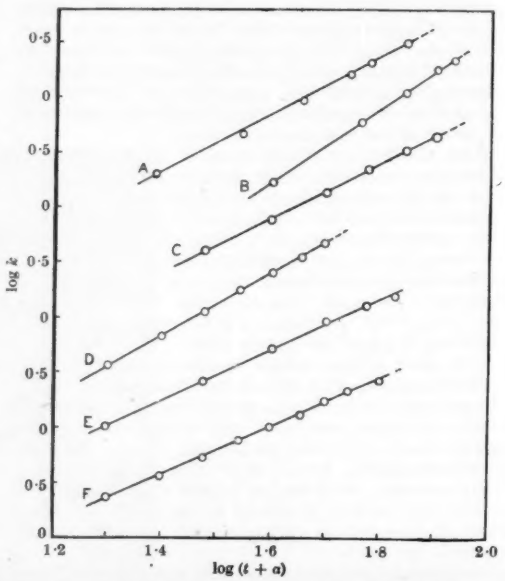

Fig. 1. Temperature-rate relationship for several enzymes. *A*, invertase from yeast, pH 5·6 (Sizer); *B*, invertase (Kjeldahl); *C*, crystalline urease (Poland, ref. 2); *D*, trypsin (Butler, ref. 7); *E*, pepsin (Ege); *F*, phosphatase (Bodansky, ref. 9)

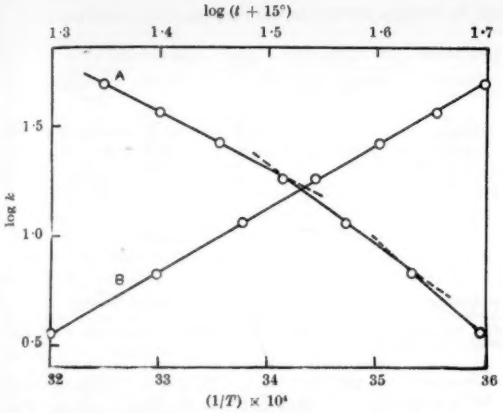

Fig. 2. Trypsin activity at various temperatures; Butler's data represented as required by the Arrhenius formula (*A*) and by the *b*–*a* rule (*B*)

uncoiled by heat denaturation, but also when coiled too rigidly[6].

The constant *b* would then indicate the steepness of this structural change with temperature, and consequently it would indicate the changes in the 'intramolecular viscosity' of the enzyme. This property would not depend on the linear thermometric scale, but on a logarithmic scale of its own, that is, with its own zero point.

The values of α and *b* for a number of enzymes, calculated from observations by various workers, are shown in Table 1.

While the constant *b* can be determined easily, there is no simple way of calculating α, and its value can only be assessed graphically with an accuracy of about 5–10°; this is inevitable and due to the logarithmic scale of the variables. The position of α as evaluated here is roughly in agreement with what can be expected from the behaviour of isolated enzymes at temperatures below 0° C.

For comparison, an example[7] is analysed by both methods in Fig. 2. It will be noted that the Arrhenius plot suggests drawing three lines, actually tangents, with three different values of μ, whereas a single value of *b* covers the whole range. Finally, the change of μ with temperature is considerable in cases where *b* is constant throughout the experimental range (see Table 2).

Table 1

Enzyme	Temperature range (°C.)	α	*b*	Authority
Malt amylase	0–40	−20	2·84	Ernström
Invertase	0–45	−40	3·36	Kjeldahl
Malt invertase	4–50	−60	4·78	Sizer
Yeast invertase, *p*H = 3·2	4–50	−30	3·04	Sizer
Yeast invertase, *p*H = 5·6	4–50	−20	3·04	Sizer
Liver lipase	0 30	− 8	0·76	Kastle and Löwenhardt
Pancreas lipase	0–30	−20	1·20	Kastle and Löwenhardt
Trypsin	5 35	−15	2·86	Butler (ref. 7)
Pepsin	0–45	−20	2·36	Ege
Urease, crystalline	5–30	−30	2·20	Kistiakowski and Lumry
Urease, crystalline	0 50	−30	2·56	Poland (ref. 2)
Bone phosphatase	5–45	−15	2·22	Bodansky (ref. 9)

Table 2

Interval of temperature	Value of μ for rate of reaction: Trypsin (ref. 7)	Phosphatase (ref. 9)
5–15	18,500	13,400
10–20	16,400	12,600
15–25	15,700	11,600
20–30	12,300	10,300
25–35	7,700	9,700
30–40	—	9,300
35–45	—	8,500

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AZASERINE, A NEW TUMOUR-INHIBITORY SUBSTANCE

Studies with Crocker Mouse Sarcoma 180

As part of a broad programme[1] in search of materials which retard growth of transplantable neoplasms in animals, a crude filtrate from a culture of a *Streptomyces* was selected for test against sarcoma 180, because of earlier results against *Erro scelestus* in eggs[2], and was found to possess potent anti-tumour activity. A marked inhibitory effect upon sarcoma 180 was detected by daily intraperitoneal injections for one week of 1 ml. of crude filtrates. The most active filtrates showed detectable anti-tumour activity even in eight-fold dilutions. Details of the sarcoma 180 inhibition test have been presented elsewhere[1]. Subsequent investigations of satisfactory conditions for production of active culture filtrates were checked at each step by tests of the activity against sarcoma 180. Ultimately a good correlation was found between the capacity to retard tumour growth and an ability to inhibit growth of the yeast *Kloeckera brevis*[2]. Thereafter it was possible to limit the anti-tumour tests to confirmation of only the more important steps in purification that led to isolation and characterization of the antibiotic substance as the new compound azaserine[3].

The crystalline antibiotic, a substituted L-serine[3], was found to be effective in amounts as low as 1–2 mgm./kgm./day. This is illustrated in Table 1, which presents data from titrations of activity of the D-, DL- and L-forms of azaserine. The results show that the activity is associated with the isomer containing L-serine, and there is an eight-fold range between the minimum effective and maximum tolerated doses. This is considerably greater than for other compounds found effective in this test system; for example, 2,4,6-tris(ethylenimino)-s-triazine (TEM) has a corresponding dose-range of three.

A full account of the effect of azaserine in a number of biological systems will be published soon. It is not clear yet whether azaserine will be useful against human cancer; but, in view of its structure and its effects in various biological systems, the compound should prove a helpful tool in biochemical studies.

The tumour studies have been supported by institutional research grants to the Sloan–Kettering

Table 1. Comparison of Isomeric Forms of Azaserine for Ability to Retard Growth of the Crocker Mouse Sarcoma 180

Dosage mgm./kgm./day	D-Azaserine			DL-Azaserine			L-Azaserine		
	Tox.*	Diam.†	Grading‡	Tox.*	Diam.†	Grading‡	Tox.*	Diam.†	Grading‡
1							−1·0	0·68	±
2				−1·0	0·71	±	−1·5	0·42	±+
4				−1·0	0·66	±	−3·0	0·28	±+
8				−3·5	0·22	+	−4·0	0·04	+
16				−4·0	0·16	+	−6·0	0·07	+
32	−1·5	0·85	—	−5·0	0·03	+	All died		?
64	All died					?			
128	−3·5	0·88	—						
256	−4·0	0·77	—						
Controls	−1·5	0·99		−1·5	0·99		−1·5	0·99	

* Average loss of weight during week of treatment (gm./mouse).
† Average diameter (cm.) of tumours.
‡ The results of the inhibition test have been graded as follows: ?, no grading because of toxicity; −, no effect because average diameter of tumours in test group was ¾ or more those of controls; ±⁻, slight retardation because average diameter of tumours in test group was ¼ to ¾ those of controls; ±⁺, moderate retardation because average diameter of tumours in test group was ¼ to ¼ those of controls; +, marked retardation because average diameter of tumours in test group was ¼ or less those of controls.

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[3] Bartz, Q. R., Elder, C. C., Frohardt, R. P., Fusari, S. A., Haskell, T. H., Johannessen, D. W., and Ryder, A., *Nature* (see following communication).

Antibiotic Studies of Azaserine

A *Streptomyces* (Parke-Davis No. 04926) was found to produce laboratory culture broths which exhibited inhibitory activity towards *Erro scelestus* in eggs, Crocker mouse sarcoma 180 in mice[1], and various Gram-positive and Gram-negative bacteria and certain fungi *in vitro*. Some of these antibiotic activities were afterwards found to be due to one or more extraneous constituents of the culture broths; but inhibition of sarcoma 180 proved to be correlated with activity shown by the broth against *Kloeckera brevis*. The sensitivity of this yeast aided materially in fermentation studies as well as in the isolation of the tumour-inhibitory substance[2], for which the generic name 'azaserine' has been adopted. When the *Streptomyces* was grown at 26° C. in a medium containing commercial dextrose, soya bean oil meal, saline-extracted hog stomach, sodium and ammonium chlorides and calcium carbonate in shaken flasks or in stirred and aerated fermenters, transitory potencies of 100–250 μgm. equivalents of azaserine/ml. of broth were attained 36–64 hr. after seeding.

Crystalline azaserine exhibits only moderate activity *in vitro* against bacteria, inhibiting the growth of one or more species of *Acetobacter*, *Agrobacterium*, *Bacillus*, *Clostridium*, *Escherichia*, *Hemophilus*, *Mycobacterium*, *Neisseria*, *Pasteurella*, *Salmonella* and *Vibrio* at 50 μgm. or less/ml. of medium. At a concentration of 250 μgm. or less/ml. of medium, azaserine also inhibits species of the following genera of fungi: *Alternaria*, *Armillaria*, *Aspergillus*, *Candida*, *Cercospora*, *Endomycopsis*, *Gelasinospora*, *Helminthosporium*, *Histoplasma*, *Kloeckera*, *Mortierella*, *Mucor*, *Mycoderma*, *Nematospora*, *Phycomyces*, *Pichia*, *Polyporus*, *Poria*, *Saccharomyces*, *Schizosaccharomyces*, *Sporobolomyces*, *Torulopsis* and *Zygosaccharomyces*. There is little or no activity against representative protozoa or viruses.

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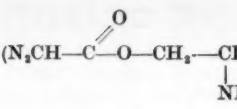
[1] Stock, C. C., Reilly, H. C., Buckley, S. M., Clarke, D. A., and Rhoads, C. P., *Nature* (see previous communication).
[2] Bartz, Q. R., Elder, C. C., Frohardt, R. P., Fusari, S. A., Haskell, T. H., Johannessen, D. W., and Ryder, A., *Nature* (see following communication).

Isolation and Characterization of Azaserine

The antibiotic azaserine, which is active against certain experimental tumours[1], was isolated from broth-culture filtrates of a *Streptomyces*[2] by chromatographic adsorption on, and elution from, successive columns of alumina and carbon. It was obtained in crystalline form after diluting the concentrated eluates from the carbon column with ethanol, warming to dissolve the precipitate, and then cooling.

Crystalline azaserine is light yellow-green in colour, very soluble in water, only slightly soluble in absolute methanol, absolute ethanol, and acetone in the cold, but soluble in warm aqueous solutions of these solvents. Acidification of an aqueous solution to *p*H 2 results in the vigorous evolution of nitrogen with a concurrent loss of biological activity; neutral solutions are relatively stable. The crystals tend to decompose before melting, and the decomposition and melting points vary over a wide range (146–162°), depending upon the method of determination; $[\alpha]_D^{27.5} = -0.5°$ (*c*, 8·46 per cent in water at *p*H 5·18); $E(1\%, 1\text{ cm.}) = 1{,}140$ at $\lambda_{max.} = 250{\cdot}5$ mμ (*p*H 7); 1,230 at $\lambda_{max.} = 252$ mμ (after 30 min. in 0·1 *N* sodium hydroxide). Little or no absorption is observed in 0·1 *N* hydrochloric acid. The most striking feature of its infra-red absorption spectrum is the presence of a pronounced peak at 4·66 μ. The absorption in the ultra-violet and infra-red regions not only provided a valuable supplement to the biological assays for following the purification of azaserine, but also contributed, along with degradation studies, to the determination of its structure as O-diazoacetyl-L-serine



This compound has also been prepared by several synthetic methods by other workers in these laboratories.

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[1] Stock, C. C., Reilly, H. C., Buckley, S. M., Clarke, D. A., and Rhoads, C. P., *Nature* (see preceding communication).
[2] Ehrlich, J., Anderson, L., E., Coffey, G. L., Hillegas, A. B., Knudsen, M. P., Koepsell, H. J., Kohberger, D. L., and Oyaas, J. E., *Nature* (see preceding communication).

ANNUAL FLUCTUATIONS IN QUARTZ CLOCK ERROR AND FREQUENCY DRIFT

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CLOCKS and time determinations. The performance of certain quartz clocks in the southern hemisphere has been investigated. Two of the clocks, designated *A* and *B*, have Essen ring crystals. The ovens, drive circuits and auxiliary equipment were designed, built and maintained by the Postmaster-General's Research Laboratories, Melbourne. The other clocks have Meacham bridge-stabilized 100 kc./s. *GT*-cut crystals and were imported. One of these, designated clock *E*, was installed in Melbourne in a room that was artificially heated but not thermostatically controlled. (The makers recommended temperature control to $\pm \frac{1}{2}°$ C.)

The determinations of clock error until October 1945 (Fig. 1 (i)) were made with the 8-in. transit circle at the Melbourne Observatory. As shown in Table 1, the observations were then continued (Fig. 1 (ii)) with the 3½-in. transit instrument at the Commonwealth Observatory, Mt. Stromlo, near Canberra. By means of radio signals, the 1946–48 clock errors were checked against the mean observations of the fourteen observatories (Fig. 1 (iii)) which form an international criterion through the Bureau International de l'Heure. The 1951–52 clock errors were referred to Washington time observations to avoid a possible weakness when the Mt. Stromlo striding level was replaced on September 11, 1951. Allowance has been made throughout for the wandering of the pole.

The results can be summarized as follows:

(*a*) The error of every clock fluctuated annually, with regard to mean solar time.

(*b*) The amplitude of the fluctuation for clocks *A* and *B* was much the same as had been reported for quartz clocks in Europe and North America[1].

(*c*) The phase of the fluctuation for *A* and *B* was several months in advance of that for the northern clocks. (The various northern quartz clocks and pendulums[2] show comparatively small, though significant, differences in phase among themselves.)

Table 1. Annual Fluctuations in Clock Error

Clock	Observatory	Period	a_1	d_1	a_2	d_2	Fig.
B	Melbourne	May 1944–Sept. 1945	56	338	6	125	1 (i)
B	Mt. Stromlo	Mar. 1946–Feb. 1948	62	342	13	44	1 (ii)
B	B.I.H.	Mar. 1946–Feb. 1948	65	337	4	78	1 (iii)
A	Mt. Stromlo	Mar. 1949–June 1950	65	307	3	139	1 (iv)
B	Washington	Feb. 1951–Aug. 1952	38	319	19	158	1 (v)

The clocks were $-\Delta T$ m.sec. fast, where $-\Delta T = a_1 \sin \frac{2\pi}{365}(d - d_1) + a_2 \sin \frac{4\pi}{365}(d - d_2)$, and d is the day of the Besselian year.

(*d*) The fluctuations in clock error for 1951–52 differed in phase and amplitude from those for 1944–50.

(*e*) The fluctuations in rate (and in oscillator frequency) were not in phase with fluctuations in ambient temperature. This applied to all the clocks.

(*f*) The fluctuations in acceleration (and in rate of oscillator frequency drift) did correlate with fluctuations in ambient temperature, in the case of clock *E*. This caused the clock error to vary by nearly ± 0·5 s., so the effect of annual fluctuations in astronomical time was relatively small.

(*g*) The existence of an annual fluctuation in the earth's rate of rotation is not disproved, the clock peculiarities having accounted for only part of the fluctuation in clock error.

Comparisons between error curves. Comparison between Figs. 1 (ii) and 1 (iii) shows that the astronomical observations made at Mt. Stromlo are in satisfactory agreement with those made at the fourteen observatories, of which all but two are in the northern hemisphere. This is confirmation that it is safe to neglect the possibility of serious anomalies in the star catalogue (*FK3*), the fluctuation of longitude or the observing conditions. Therefore, the difference in the behaviour of the southern clocks (Fig. 1) and the northern clocks (Fig. 2) must have arisen in the clocks themselves, and not in the determination of time.

In 1950 the clock errors tended towards the type of curve which is shown for 1951–52 (Fig. 1 (v)). The change from the earlier type (Fig. 1 (iii)) to the later type (Fig. 1 (v)) is given in Fig. 3 (i). A somewhat different change in 1950 was shown by the Greenwich Time Service (Fig. 3 (ii)) and attributed to a change in the behaviour of the earth[1]. It is now shown that at that time there had been an alteration in the relationship between the curves for Greenwich and Melbourne. The origin of this alteration is not known, and consequently the errors of more clocks must be examined for evidence of a change in the earth's rate of rotation.

Fluctuations in rate of frequency drift. So far as is known, clocks *A* and *B* were not affected by meteorological changes, as no correlation could be found between deviations from the mean annual cycle of room temperature and deviations from the mean fluctuation of clock error. However, the error of clock *E* was found to vary almost directly (Fig. 4 (i)) with the seasonal changes in temperature (Fig. 4 (ii)), whereas the rate (and oscillator frequency) fluctuated in quadrature with the temperature. In other words, when the clock error, or the temperature, is represented by a sine series, then the rate is given by a cosine series; but again there is a sine series to represent the acceleration or the rate of frequency drift. It follows that it was the acceleration, rather

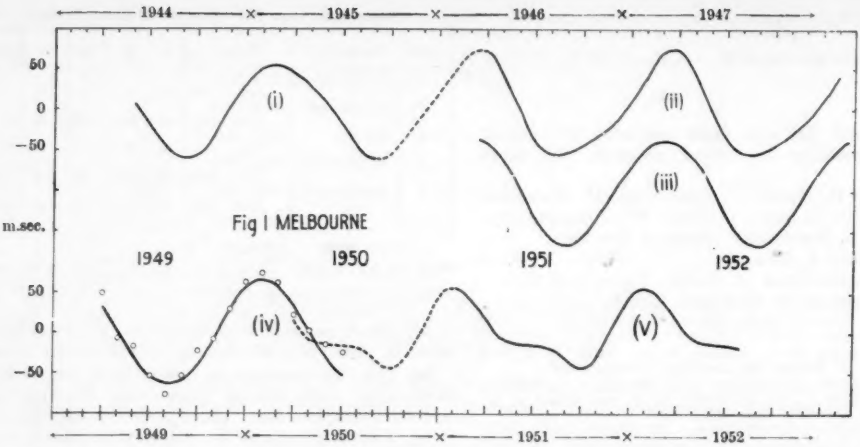

Fig. 1. Errors of Melbourne clocks *A* and *B* (see Table 1)

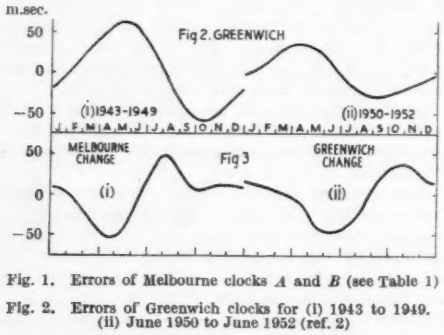

Fig. 2. Errors of Greenwich clocks for (i) 1943 to 1949. (ii) June 1950 to June 1952 (ref. 2)

Fig. 3. Changes in error curves for (i) Melbourne clocks (Fig. 1 (iii)–Fig. 1 (v)); (ii) Greenwich clocks (Fig. 2 (i)–Fig. 2 (ii))

than the clock rate, that had been inversely affected by the changes in temperature, or similar seasonal influence. It also follows from the phase of the fluctuation in rate that the oven and sealed holder were protecting the crystal comparatively well against any meteorological effects. The greater part of the fluctuation was apparently coming from a variation in the rate of ageing, and this could only occur in the exposed external circuits.

If the weather could affect the ageing of the circuit elements, it might also affect their instantaneous values; that is, there would be an immediate variation in frequency, as well as a variation in frequency drift. Then there would be a resultant formed by two frequency variations in quadrature with each other. The instantaneous component should not be difficult to measure, and would have to be corrected; otherwise it would be supposed that the earth was rotating too quickly (or slowly) in summer and too slowly (or quickly) in winter. The other component, due to a fluctuation in the rate of ageing, is more likely to escape notice, since it can only be detected and measured when comparisons are made against some known standard over an extended period.

Thus, clock error curves have to be regarded as the resultant of various uncertain components until it has been proved that the clock has adequate stabilization against long-term variations in the power supply and against ageing in the circuit elements. If this is not done, theories about the physical cause of variations in the earth's rate of rotation could become based upon false data. For example, there are other clocks and frequency standards, which have the same general design as clock *E* and which are mostly situated within 8° from lat. 46° N., where they have much the same annual weather cycle in common. It is evident that it is of great importance to ensure that the mean quartz clock acceleration cannot be systematically affected.

Nevertheless, peculiarities of the clocks have accounted for only part of the annual fluctuation in error. Careful work in the northern hemisphere[2] and the substantial agreement between quartz clocks and pendulum clocks[3] has shown there is no reason for doubting that there is an actual fluctuation in the rate of the earth's rotation.

I am indebted to Prof. J. Schilt and Prof. R. v. d. R. Woolley for helpful criticism, and to the Director-General of the Postmaster-General's Department for permission to include data about the frequency standards at the Research Laboratories.

[Sept. 16.

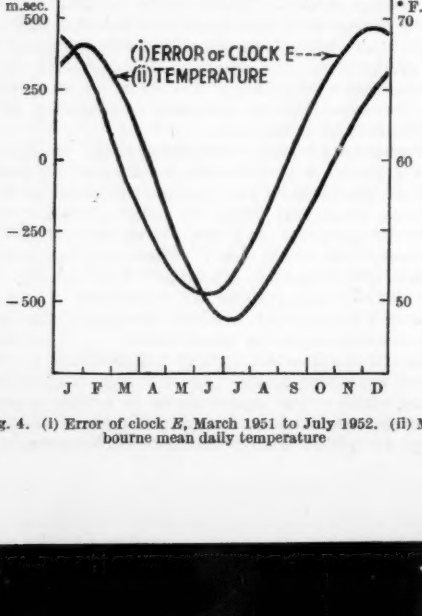

Fig. 4. (i) Error of clock *E*, March 1951 to July 1952. (ii) Melbourne mean daily temperature

[1] Smith, H. M., *Inst. Elec. Eng., Mon.* No. 39 (1952).
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LETTERS TO THE EDITORS

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Crystal Structure of Benzene at − 3° C.

A PRELIMINARY determination[1] of the crystal structure of benzene at − 22° C. showed that the crystals are orthorhombic, space-group *Pbca*, with four centro-symmetrical molecules in the unit cell, and that the normals to the planes of the molecules are roughly perpendicular to the *b*-axis and inclined at about 50° to the *c*-axis. We have now completed the first stage of refinement of the structure at − 3° C. Crystals were grown in Lindemann glass tubes of wall thickness 0·05 mm. and bore 0·36 mm. by the method of Keesom and Taconis[2] as modified by later workers[3]. 288 independent reflexion intensities representing 56 per cent of the total possible with copper radiation were estimated visually from oscillation photographs about all three principal axes. Chromium-*K* radiation was used to obtain accurate values of the unit cell dimensions by the Straumanis method; the revised dimensions are $a = 7{\cdot}46_0$, $b = 9{\cdot}66_4$ and $c = 7{\cdot}03_4$ A.

Adjustments to the carbon atom co-ordinates of the original analysis were first made by a Fourier transform method and by plotting difference projections on (100) and (001). The process was completed by five cycles of three-dimensional refinement on the University of Manchester electronic computor, using programmes for differential syntheses in the space-group *Pbca* prepared by Drs. F. Ahmed, D. W. J. Cruickshank and P. J. Wheatley[4]. The contribution of the hydrogen atoms to the calculated structure factors was included on the assumption that these atoms are situated at a distance of 1·08 A. radially from the carbon atoms. The values of the temperature coefficients B used for the carbon and hydrogen atoms were 6·0 and $9{\cdot}0 \times 10^{-16}$ cm.^{2} respectively. Corrections for termination of series errors were applied by the method of Booth[5]. The 'disagreement index' now stands at 14 per cent.

As the molecules are centro-symmetrical, three independent values of the C—C bond lengths and of the CCC angles are obtained from the analysis; these are:

Bond-lengths (A.)		Bond-angles	
C_1C_2	= 1·377	$C_6C_1C_2$	= 119° 28′
C_2C_3	= 1·382	$C_1C_2C_3$	= 120° 49′
C_3C_4	= 1·374	$C_2C_3C_4$	= 119° 42′
Mean	= 1·378	Sum	= 359° 59′

The mean standard deviation[6] of the atomic co-ordinates is 0·0057 A.; the standard deviation of the C—C bond-length after allowing for internal correlation is $0{\cdot}0057/\sqrt{3}$ or 0·0033 A. The small differences between the three independent bond-lengths are thus not significant; but there appears to be a significant difference between our mean value of 1·378 A. and the preliminary value of 1·396–1·401 A. obtained by Stoicheff[7] from his measurements on the Raman spectrum of the vapour at 61° C.

The best plane through the molecule is:

$$0{\cdot}7109x + 0{\cdot}2229y + 0{\cdot}6671z = 0,$$

the origin being at the centre of symmetry and the co-ordinates (x, y, z) in angström units. The perpendicular distances of the carbon atoms from this plane are:

C_1 − 0·0015, C_2 + 0·0015, C_3 − 0·0015 A.,

showing that the molecule is accurately planar. The normal to the molecular plane is inclined at 77° to the *b*-axis and 48° to the *c*-axis.

Further work is now in progress to locate the hydrogen atoms, and it is proposed to extend the investigation to lower temperatures.

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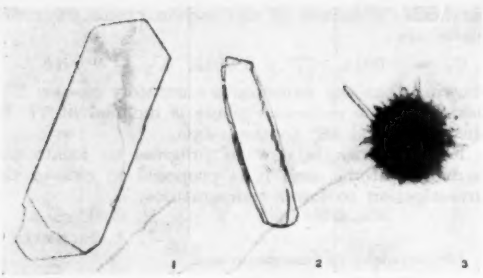
Effect of a Citrate Ion Impurity on the Size and Shape of Calcium Phosphate Crystals

IT is commonly observed that a change in the size and shape of a crystal occurs when an impurity is added to the solution from which the crystal is grown. One such change, or habit modification, is that of crystals of gypsum (calcium sulphate), which in the presence of sodium citrate change from long needles to short stubby rods[1]. The mechanism of such habit modification of crystals is obscure, but the impurity is believed to be adsorbed on the surfaces of the growing crystal, and thus to cause an alteration in their rates of growth which results in the observed change in size and shape. Since the calcium and citrate ions associate in solution to form a complex, it was possible that other calcium compounds than gypsum adsorb the citrate ion, leading to habit modification of their crystals. In fact, the surface of the calcium phosphate crystals in bone has been supposed to be the site of the bone citrate[2]. It is therefore of interest to investigate the effect of citrate on the growth of calcium phosphate crystals.

To prepare calcium phosphate crystals[3], a 0·1 *M* phosphate solution at *p*H 7·4 is obtained by mixing 789 ml. of 0·1 *M* disodium hydrogen phosphate with 211 ml. of 0·1 *M* dihydrogen sodium phosphate solution. On the addition of this phosphate solution to a 0·1 *M* solution of calcium chloride, a white precipitate is formed throughout the solution. After approximately an hour, however, the solution clears, the precipitate having fallen down as small tabular crystals of about 1 mm. in length (Fig. 1). The rate at which the precipitate crystallizes out of the solution appears to be dependent on the ratio of dibasic to monobasic sodium phosphate, that is, on the *p*H of the phosphate solution; the higher the *p*H, that is, the higher the concentration of dibasic sodium phosphate, the slower is the rate of crystallization and the greater the amount of precipitate formed. The crystals, however, remain the same in size and shape. The *p*H selected was 7·4. This is convenient because the crystals are formed in good quantity and fairly rapidly. In addition, this is the *p*H of the blood.



Citrate content of solution	Ratio: citrate ions / calcium ions	Length crystal ($\mu \times 10^2$)	Description	Figure
0	0	27	flat, elongated, hexagonal	Fig. 1
0·8 ml. 10^{-3} *M*	1 : 375	14	stubby, thickened	Fig. 2
0·5 ml. 10^{-1} *M*	1 : 6	7	many-pointed	Fig. 3

To discover the effect of citrate impurity on the crystallization, citric acid in amounts varying from 0·1 ml. of 10^{-3} *M* solution to 0·8 ml. of 10^{-1} *M* solution were added to 3 ml. of 0·1 *M* calcium chloride, followed by 3 ml. of the phosphate solution. The changes of crystal habit are shown in Figs. 1–3.

As the citric acid content is increased, the amount of precipitate is decreased as well as the size of the crystals, until with 0·8 ml. of 10^{-1} *M* citric acid no visible precipitate is formed. At this point the *p*H of the mixed calcium and phosphate solutions is 4·8 as compared with 5·2 for a solution containing no citric acid. It is felt, however, that the effects described are not attributable to *p*H changes, since the same effects were seen when sodium citrate was used instead of citric acid.

The changes of shape of the crystals with increasing citrate impurity may be attributed to a greater adsorption of citrate ions on certain faces, presumably those with a higher concentration of exposed calcium ions. Thus the rates of growth of the different faces are affected to a different extent by the impurity and the shape change. The decrease in size of the crystals may be explained in the same way by an increase of surface-adsorbed citrate ions tending to block growth. On the other hand, it may be simply due to the increase in calcium ions bound in the solution by the citrate and the resulting decrease of calcium ions available for growth of crystals.

Differences in size and shape also exist for the calcium phosphate crystals in bony tissues—enamel crystals[4] have a length of 10^{-2} to 10^{-4} cm., dentine crystals[5] 10^{-5} to 10^{-6} cm., and bone[6] 10^{-6} cm. or less. This may be related to a parallel increase in citrate content, since dentine contains five to eight times more citrate than enamel, and bone about three times as much as dentine[6].

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Measurement of Spark Spectrum Intensities in the Vacuum Ultra-Violet with a Photomultiplier sensitized to Fluorescence

The photomultiplier sensitized to fluorescence has recently been used in the vacuum ultra-violet to measure intensities in the spectrum of the direct-current hydrogen arc[1]. The short-wave limit of this spectrum occurs at 850 A., however, and intensities are too low to be useful below 1000 A., while there are several regions of low intensity below 1500 A. Since most alternative sources of vacuum ultra-violet spectra make use of either sparks or pulsed discharges, it is desirable to adapt the photomultiplier to record the spectrum of such an intermittent source.

This has now been achieved by using a peak voltmeter[2] to measure the height of the pulse from a photomultiplier, type E.M.I. 6094, the cathode window of which is coated with sodium salicylate. The cathode current of the final cathode-follower stage of the voltmeter passes through a galvanometer of period 1·25 sec., the movement of the spot being recorded photographically.

Two recordings of part of the spectrum of a pulsed discharge are shown in Fig. 1, the close matching of the two traces providing an indication of the reproducibility of the spectrum. In this case a capacity of 0·7 μF., charged to 12 kV., was discharged through a 1-mm. 'Pyrex' capillary about 100 times a minute, hydrogen flowing through the capillary at a pressure of about 2 mm. mercury. The normal-incidence spectrograph slit was 0·035 mm. wide, the photomultiplier slit 0·005 mm., and the dispersion 0·058 mm. per A. The spectrum was scanned at about 0·25 A. per sec. by turning the grating. The 'dispersion' on the photographic record is about 2·5 mm. per A. In the interval between sparks the charge on the voltmeter condenser decays, producing serrations with a spacing of 0·4 mm., which can be seen on the record.

Some identification of the lines is given, the second-order lines in this region having been observed in considerably greater intensity in the first order. Lines of oxygen, silicon and nitrogen have been recorded down to 480 A.

The variation of galvanometer deflexion with intensity has been examined by changing the width of the photomultiplier slit in a region free from lines. The relationship is found to be linear so long as the output pulse from the photomultiplier does not exceed about 15 volts.

The light pulse decays rapidly, so the period during which the voltmeter operates is controlled by a gate circuit which is opened by the spark, the measured intensity being the value at the time the gate closes. As it has been found that intensities in

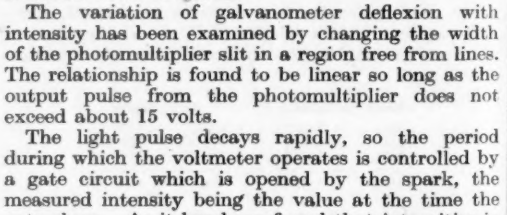

Fig. 1. Two records of part of the spectrum of a pulsed discharge through a 'Pyrex' capillary: ——, zero light; – – – –, approximate level of scattered light

a spark at atmospheric pressure decay very rapidly[3], we have examined the effect of varying the length of the gate. It is found that so long as the gate-length is less than about 40 microsec., the maximum intensity is observed for a number of lines of O I, O IV, O V, Si I, Si III and Si IV.

We wish to acknowledge the contributions of Mr. R. L. Falconer and Miss N. E. White to the initial stages of this work.

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Electromagnetic Waves emitted on Detonation of Explosives

In studying the propagation of stress waves through solids, small quantities of explosive have been used to produce sharp stress pulses. In this work it was found that a small electrical disturbance starting at the instant of detonation could be detected; and since this appeared to have been produced by the explosion products, some separate experiments were carried out to investigate the effect.

The apparatus used for detecting the pulse consisted of a probe in the form of a wire 10 cm. long which was connected to the input of a wide-band amplifier, the output of which was displayed and photographed on a high-speed cathode-ray oscillograph. The oscillograph trace was triggered by the light output of the explosion by means of a photocell. A sheet of 'Perspex' was placed between the probe and the explosive, the probe being between 5 and 100 cm. from the explosive in the various experiments. Four explosives were tried, namely, lead azide, silver acetylide, nitrogen tri-iodide and P.E.T.N. For the first three, a fraction of a gram of explosive was placed on an insulating base and detonated with either a hot glass rod or an electrically heated wire. (The results were the same in both cases, showing that the heating wire was not producing any of the observed effects.) The P.E.T.N. was in the form of instantaneous fuse, 5 cm. of which (containing about 1 gm. of P.E.T.N.) protruded through a small hole in an earthed steel plate, a detonator being affixed to the other end. Preliminary experiments were made with a detonator alone to ensure that any electrical pulse produced by it could not be detected at the other side of the earthed plate.

In all cases the effect observed was that the probe reached a maximum potential after a time of the order of fifty microseconds, which decayed to zero over a period of a few hundred microseconds. For P.E.T.N. the potential acquired was negative, whereas for the other three explosives it was positive. The nitrogen tri-iodide results were, however, a little uncertain, due both to the temperamental nature of this explosive and to the fact that it does not emit light during detonation, so that triggering was more difficult to effect. In the lead azide experiments there was also some evidence of a very small negative pulse preceding the positive pulse. A quantitative estimate of the effect may be gained from the result that, with 0·1 gm. of lead azide and the probe 10 cm. away, the maximum potential of the probe was about + 100 millivolts.

A probable explanation of the effect is that during the expansion of the explosive products which, as a result of their high temperature, are highly ionized, the positive and negative ions have different mobilities so that the distributions of positive and negative charges are different, the effect being that of the sudden creation of an electrical dipole. The effect of this dipole increases during the first few tens of microseconds due to continued expansion of the gas, and then decreases due to recombination. The reason that the charge is opposite in sign for the two explosives containing metals on one hand and P.E.T.N. on the other may be that in the former the electropositive atom is the heavier, whereas for P.E.T.N. hydrogen will be the most electropositive constituent.

I wish to thank Mr. D. G. Christie for his help with some of these experiments.

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Suppression of Bubble Initiation of Liquid Explosives

It has been established[1] that the presence of air bubbles in a liquid explosive such as nitroglycerine renders it peculiarly susceptible to initiation by mechanical shock, that such ignitions start at or in the bubble, and that certain organic vapours like carbon tetrachloride, ether and pentane tend to suppress this type of ignition. In another connexion, it has been shown[2] that ignition requires both a critical temperature and a critical quantity of heat, and also[3] that complex organic vapours, which decompose endothermally below the critical temperature, act as explosion inhibitors. Taking these circumstances together, a simple method of suppressing bubble initiation is suggested, thereby reducing the fire and explosion hazard in pressing, rolling and extruding certain thermoplastic explosive compositions.

When hydrostatic pressure is applied to an 'incompressible' fluid containing an air bubble, energy can be absorbed only as work done on the bubble, and any such work must appear as heat in the compressed gas. If the compression is sudden, as in an impact, loss of heat by conduction will be negligible and the gas is compressed adiathermally or, assuming ideal conditions, adiabatically. On our hypothesis, an ignition will take place if the compressed bubble both contains more than a certain critical amount of heat and if the temperature of its contents exceeds a certain critical value. It will be evident that a simple formal solution of the problem of bubble initiation is possible if these two critical quantities are known.

In the ideal case postulated above, the heat generated in the bubble is simply the thermal equivalent of the mechanical energy lost in the impact and, in a 'fall-hammer' apparatus, this is ostensibly

given by the product of the mass of the striker and the height of fall. For bubble initiation of nitroglycerine, this quantity appears to be of the order of 200 gm.cm., or 5×10^{-3} cal.; but most of this energy is dissipated elsewhere and only a small fraction appears as work done on the bubble. Thus, Bowden and Yoffe estimate the critical compression ratio for ignition to be about 20 : 1 and the heat generated about 10^{-3} cal. These figures illustrate the very low efficiency of impact machines, however well constructed.

It may be calculated that a spherical bubble of 1 mm. diameter contains, at ordinary temperatures, sufficient nitroglycerine vapour to generate approximately 10^{-6} cal. of heat on explosion. Bowden *et al.*[4] have shown that ignition always starts inside the bubble and, moreover, that an ignition can occur in the bubble without communicating it to the surrounding liquid. It appears, therefore, that ignition of the explosive vapour is an intermediate event the contribution of which to the temperature and heat content of the 'hot-spot' is comparable in magnitude with that of the compression. In fact, the bubble may be likened to a compression-ignition engine the output of which is applied to the heavier task of initiating the surrounding liquid explosive. It is necessary, therefore, to distinguish between the ignition of the vapour and the initiation of the liquid explosive.

At low temperatures, the vapour concentration is low and the bulk of the energy needed to initiate the liquid must be generated by compression; at high temperatures, the vapour pressure is high and it requires only enough compression to ignite the vapour to ensure the release of an abundance of energy. It follows, therefore, that the fall-hammer result should be high at low temperatures and low at high temperatures. In fact, there should be two distinct energy-levels, one corresponding to the direct initiation of the liquid explosive and the other to the ignition of the vapour, with a transition stage between, that is, in the region where the contributions from the two sources are more or less equal.

At low initial temperatures, the rise in temperature of the gas for a given expenditure of work will vary inversely as the initial pressure, so that, at low ambient pressures, the temperature criterion for ignition will be readily met. The determining factor will then be the energy, the very factor which the fall-hammer apparatus purports to measure. At high initial pressures, however, the final temperature tends to be low and, to satisfy the temperature criterion, heat will have to be generated in excess of the critical amount. In other words, the fall-hammer result should be relatively constant below a certain initial pressure but should increase above it. This seems to be the case[5].

Assuming, then, that the criteria for ignition are as postulated, it follows that complex organic vapours, which dissociate endothermally below the ignition temperature, form ideal explosion inhibitors. As with change of state, when dissociation sets in, the temperature tends to remain constant until the process is complete and, if this occurs below the ignition temperature, ignition is inhibited. Moreover, the heat absorbed in the process reduces the calorimetric value, or explosion potential, of the medium as a whole. Thus, these substances attack both ignition criteria simultaneously.

Where the ignition of the explosive vapour plays a significant part in the initiation of the condensed explosive, a specific effect may be detected. Assuming, for example, that the heat absorbed in the dissociation of a molecule of the inhibitor is only one-tenth of the heat of explosion of a molecule of nitroglycerine, then the nitroglycerine vapour in the bubble can be neutralized by introducing ten times as much of the inhibitor. As the vapour pressure of nitroglycerine at ordinary temperatures is only about 10^{-3} mm. of mercury, the vapour pressure of the inhibitor need only be 10^{-2} mm. to produce the desired effect. If the inhibitor is very volatile, a very small quantity dissolved in the nitroglycerine will give the necessary concentration of vapour in any bubbles present in the liquid. Moreover, when the hazardous operation is completed, the inhibitor will quickly evaporate, leaving the explosive uncontaminated.

The analogy with change of physical state is suggestive, and I hope to enlarge on this point elsewhere; but it is worth noting here that, as Bowden and his collaborators have shown, both impact and friction initiation of explosives are also inhibited by the presence of solids melting below the critical temperature for initiation, which for nitroglycerine seems to be about 500° C.

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Influence of Fading on the Measurement of Mass Ratios in Nuclear Emulsions

A determination of the relative masses of π- and μ-mesons by photoelectric measurement of track densities in an Ilford *G5* plate was described by von Friesen and Kristiansson[1]. The measurements yielded results which deviated appreciably from 1·32, but no explanation of the anomaly could be given[2]. It now appears, however, that the matter can be explained as a photographic fading effect.

The emulsion on which the measurements were made was exposed in the course of a very short-lived balloon flight. Prior to the flight, the plates had been stored in the laboratory for several months in conditions conducive to fading. The total exposure thus comprised tracks from the balloon flight together with tracks formed during storage. Because of the composition of the radiation at different altitudes, one may assume that the π-mesons in the plate appeared principally during the balloon flight, whereas a considerable number of the μ-meson tracks were formed during storage. At the time of processing, many of the μ-meson tracks were therefore appreciably older than the π-meson tracks. Fading in this way reduced the average μ-meson track density, leading to too high a value for the mass ratio.

The adverse effect exerted on the developability of the grains by the destruction through fading of development centres is greatest when the number of original centres is least. The relative lowering of the grain density is therefore greater at low ionization[3]. Fig. 1 shows this lowering of the grain density cal-

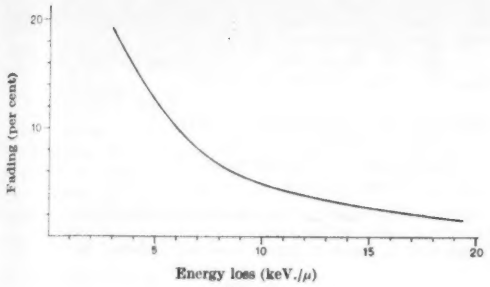

Fig. 1

culated from the measurements of the earlier communication[1]. This explains the apparent increase in the mass-ratio (see Fig. 1 of ref. 1). The fact that the curve ceases to rise beyond a certain range depends on the method of calculation in such a way that the increase in range more than compensates for the diminution of grain density through fading.

This explanation is based on: (1) the published measurements; (2) a series of plates with approximately the same history but which were more strongly developed; the apparent mass-ratio in these plates was 1·6; (3) a series of exposed plates which were stored so that fading could not occur; the mass-ratio obtained in this case was the correct one; (4) investigations by G. Leide (private communication) of fading in *G*5 emulsions.

The excessive density of proton tracks relative to the π-meson density appears to be caused by the fact that the resolution into protons, deuterons and tritons was uncertain in the first photoelectric measurements, and the value given for the proton density was a composite one obtained from both proton and deuteron tracks.

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Occurrence of a Fission-Dust Particle in a Nuclear Emulsion

IN the microscopic examination of an Ilford Nuclear Research emulsion exposed to cosmic radiation in the stratosphere, an unusual radioactive inclusion was noted. As shown in the photomicrograph (Fig. 1), the embedded particle is strongly beta-active and when examined under conditions of higher resolution the tracks originate from an opaque, nearly spherical granule with a diameter of 5–10 microns. One alpha-particle track with a recorded range of 14 ± 1 microns is associated with the embedded grain. The fused appearance of the inclusion, together with its beta- and alpha-activity, suggests that it may have originated from an atomic weapons detonation.

The grain is embedded 125 microns below the air interface of a 1,500-micron *G*5 plate manufactured at Ilford, London, on January 16, 1952, which was developed on March 30, 1952. Based on a diameter of 10 microns, an exposure period of 74 days, an assumed density of 3 gm. cm.$^{-3}$ and a count of

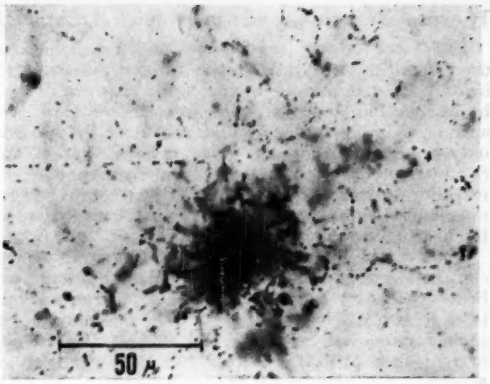

Fig. 1. Photomicrograph of fission-colloid embedded in an Ilford *G*5 emulsion

100 ± 50 recorded electron tracks, the average specific activity of the inclusion over the period between manufacture and development is estimated at 10^4 beta-decays per sec. per gm. This is a lower limit based on an apparent diameter the exact extremities of which are poorly defined owing to the large number of developed silver grains near the surface of the spherule. The true diameter might be as small as 5 microns, which would increase the estimate of the activity eightfold.

The position of this fission-colloid suggests that it was incorporated in the emulsion during manufacture as a contamination in either the gelatin, silver compounds, or the water. The active grain may conceivably have been airborne, settling on the surface of the freshly poured plate and sinking to a depth of 125 microns, where it remained suspended when the warm emulsion cooled to its jelling point.

This fission-type occlusion is the only one noted in the examination of 29 c.c. of emulsion of the same batch (*Z*5699). In all, about 300 c.c. of electron-sensitive emulsion has been scanned in this laboratory, in which twenty-four polonium radio-colloid aggregates and six alpha-radioactive macro-inclusions have been noted. The latter are chiefly translucent grains 6–33 microns in diameter associated with an aura of alpha-particle tracks the ranges of which suggest an origin from either the radium or thorium series. Their specific activity varies between 170 and 13,500 alpha-decays per sec. per gm., which is roughly 10^4 times greater than the alpha-activity of the rocks of the earth's crust. The activity of these macro inclusions appears to diminish with increase in particle size, suggesting that the activity originates from a surface adsorption deposit.

Collectively, the naturally occurring alpha-active inclusions occur with a frequency of 0·1 per c.c. of emulsion. If we assume that these bodies were introduced into the emulsion chiefly via the gelatin component, their concentration is increased to 0·2 per c.c., and this value may be indicative of the approximate abundance of strongly alpha-active segregates in normal biological tissues. A more detailed account of this study will be published elsewhere.

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Thermal Treatment of Raney Nickel Catalyst

It is well known that nickel catalyst, which is used in catalytic hydrogenation, is very sensitive to heat. In general, at higher temperatures of the hydrogenation reaction the decrease of catalytic activity is more rapid. I think this may be due not only to external factors, such as poisoning of the catalyst, etc., but also to internal factors, such as metallurgical sintering, etc., and I have surveyed by means of the electron microscope the changes caused by heating Raney nickel catalyst.

Four samples of the catalyst containing 49·96 per cent nickel were developed by the usual method[1] and heated at 250°, 300°, 350° and 400° C. respectively in a stream of hydrogen for 3 hr.; the activity of each sample was measured by finding the volume of hydrogen absorbed during the hydrogenation of acetone. The results are shown in Table 1.

Table 1

Sample No.	Temp. (° C.)	Hydrogen absorbed (c.c.)		Activity (per cent)
		Before heating	After heating	
1	250	190	186	98·3
2	300	192	183	95·3
3	350	188	123	65·4
4	400	191	71	37·1

Photographs of the Raney nickel alloy before development, after development, and after heating at 400° C. are shown in Figs. 1, 2 and 3 respectively.

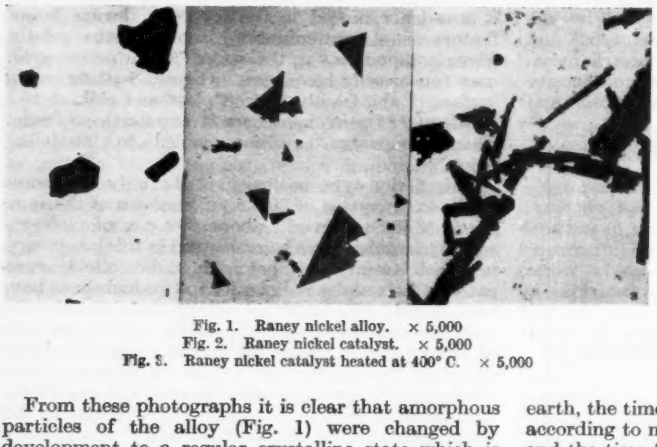

Fig. 1. Raney nickel alloy. × 5,000
Fig. 2. Raney nickel catalyst. × 5,000
Fig. 3. Raney nickel catalyst heated at 400° C. × 5,000

From these photographs it is clear that amorphous particles of the alloy (Fig. 1) were changed by development to a regular crystalline state which is pyramidal (Fig. 2); further, the pyramidal crystals changed to columnar crystals on heating (Fig. 3). This change of amorphous particles to pyramidal crystals is due to the following reaction:

$$\text{Raney alloy} + \text{NaOH} \rightarrow \text{Raney catalyst} + \text{NaAlO}_2 + \text{H}_2.$$

Crystals of the catalyst seem to come from the alloy particles by dissolving out the aluminium contained in them. F. Fischer[2] named this type of nickel catalyst 'skeleton nickel', and the pyramidal crystals shown in Fig. 2 may correspond to his 'skeleton'.

This Raney nickel catalyst contains 82 per cent nickel and about 17 per cent aluminium; therefore, the aluminium contained in Raney alloy is not dissolved completely by the usual development, and the amount of aluminium in the catalyst will vary with the initial amount in the alloy[3].

I wish to thank Mr. T. Kubomatsu and Mr. N. Kato for their help in this work.

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Proposal for a New Æther Drift Experiment

Although all experiments of the type of the Michelson experiment (with the exception of Miller's experiment) have shown that the second-order effects predicted by classical (non-relativistic) optics as results of an 'æther drift' do not exist, no experiments seem to have been carried out for testing whether such second-order effects could not be detected with *standing* electromagnetic waves. In view of the fact that the frequencies of microwaves in the centimetre region can now be measured with extraordinary accuracy, such waves could be used for this purpose with great advantage.

The following idealized experiment is suggested. A wave, generated by a suitable microwave generator, penetrates a hole at one end of a resonator in the form of a tube of length l with two perfectly reflecting parallel end-plates (or simply into the interspace between two such mirrors, travelling in the direction of their normal). The condition for resonance is that nodes are formed at both ends. This will be the case when the time a certain phase φ takes to travel from the entrance end to the far end (where a phase jump π occurs) and back again is equal to an integral multiple n of the periodic time T of the oscillator; this ensures that the phase $\varphi + 2n\pi$ enters the tube just when the reflected phase $\varphi + \pi$ returns.

In the absence of an æther drift one has, of course, $\nu = nc/2l$. But if the tube points in the direction of translational movement (velocity v) of the earth, the time for the journey in the direction of v is, according to non-relativistic optics, equal to $l/(c - v)$ and the time for the return journey in the opposite direction is equal to $l/(c + v)$. Thus the condition for resonance is $nT_1 = 2lc/(c^2 - v^2)$, and the resonance frequency will be:

$$\nu_1 = \frac{n(c^2 - v^2)}{2l} = \nu\left(1 - \frac{v^2}{c^2}\right).$$

If the tube is at right angles to the direction of v, the times for the journeys to and fro are the same and equal to $l/\sqrt{c^2 - v^2}$, and the resonance condition is now $nT_2 = 2l/\sqrt{c^2 - v^2}$, from which it follows that the resonance frequency is:

$$\nu_2 = \frac{n}{2l}\sqrt{c^2 - v^2} = \nu\sqrt{1 - \frac{v^2}{c^2}}.$$

Thus the resonance frequency for the position of the tube in the direction of v is seen to be *smaller* than that for the position normal to v by a factor

$\sqrt{1 - v^2/c^2}$. If, therefore, the apparatus is tuned to resonance in the first position and then the resonator turned through 90° (the generator being kept stationary), it ought to be necessary to retune it to a slightly higher frequency. The experiment should preferably be carried out at a high altitude.

Assuming $v/c \sim 10^{-4}$, the frequency difference for centimetre waves should be about 150 c./s. The absence of such an effect would be a new and independent confirmation of the validity of the special theory of relativity, whereas a positive effect would contradict the principle of relativity.

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An Electrical Effect in Liquid Crystalline Solutions containing Amphiphilic Salts

A CHARACTERISTIC feature of micellar solutions containing amphiphilic compounds is the segregation of liquid amphiphilic regions within the solution[1].

In certain circumstances, which have been discussed in detail elsewhere[1], this process may result in the formation of very interesting lamellar or smectic liquid crystalline solutions. These solutions are characterized by high and anomalous viscosity and by showing marked birefringence. If they are stirred, or when they are drawn into capillaries, considerable tracts of the solution may be given a definite orientation which, in the absence of further disturbance, may be retained for weeks (for references, see footnote 1). In the absence of such orientation, all possible arrangements of liquid crystalline regions must be presumed to occur.

It is interesting to speculate what effect an applied potential difference would have on the ions within such an unorientated liquid crystalline solution. Let us consider two liquid crystalline regions, of the extreme orientations shown at I (*a*) and (*b*), Fig. 1, held between two electrodes. If now a potential difference is applied as in II, one might expect that the mean alignment of the molecules at (*b*) would be unaffected, but that at (*a*) a definite alteration in the mean alignment of the molecules would be produced through ionic migration. Since the refractive indices along and across the paraffin chains are different, the change I*a* → II*a* should produce a change in refractive index in the direction *XY* at (*a*), whereas no such change would occur at (*b*). If the solution, containing a random arrangement of regions such as (*a*) and (*b*), initially appears clear

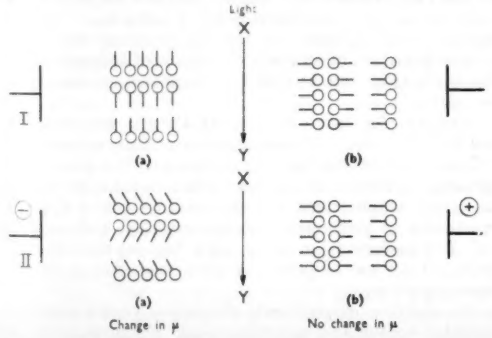

Fig. 1. Effect of an applied potential difference on differently orientated regions of liquid crystal

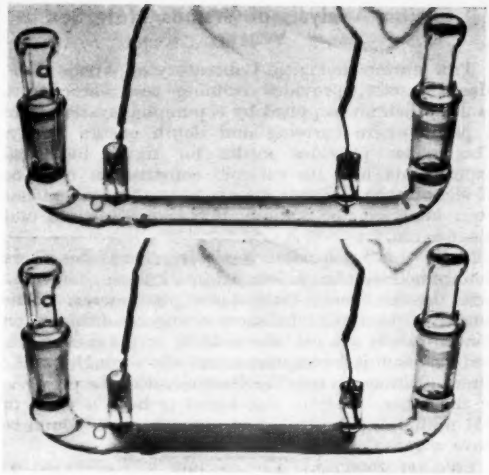

Fig. 2. A 20 per cent (w) liquid crystalline solution of tetradecane-7 sodium sulphate photographed against a white background: above, with no applied P.D.; below, with an applied P.D. of the order of 30 volts/cm.

(or almost clear), an alteration in the arrangement of the (*a*) regions on the application of a potential difference, while the (*b*) regions remain unaffected, might lead to the appearance of turbidity.

This is possibly the origin of the effect shown in Fig. 2, which illustrates the marked turbidity that appears almost instantaneously on applying a potential difference of the order of 30 volts/cm. to an almost clear liquid crystalline solution (20 per cent w) of tetradecane-7 sodium sulphate in water. On removal of the potential difference, apart from changes due to electrolysis in a small region around the electrodes, the turbidity rapidly disappears. This would be expected on account of the relaxation of the distorted liquid crystals through thermal motion. A turbidity is not produced on application of a 50-c./s. A.C. potential difference of a similar order to this solution.

A turbidity was also observed on application of a continuous potential difference to other aqueous liquid crystalline solutions; for example, tetradecane-7 potassium sulphate (*c.* 20 per cent w), 'Aerosol *OT*' (20 per cent w)[2], or pentadecane-8 sodium sulphate (3·1 per cent w).

The liquid crystalline solution (described in ref. 1, Fig. 2 (5)) containing undecane-3 sodium sulphate solution (5 ml., 20 per cent w), hydrocarbon *B* (5 ml.) and octanol-1 (1·2 ml.) also showed a similar reversible production of turbidity on the application of a potential difference.

Attempts were also made to observe whether a similar turbidity could be obtained with liquid crystalline solutions similar to that described in the preceding paragraph, but with polyethylene glycol mono-oleate in place of undecane-3 sodium sulphate as amphiphilic compound. Sodium sulphate was added to provide conducting ions. Negative results only were obtained.

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Cation Analysis of Woods Hole Sea Water

The Marine Biological Laboratory at Woods Hole, Massachusetts, provides running sea water from tanks which are supplied by a pumping system from a point where currents and depth ensure purity. This water provides media for many biological experiments and its cationic constitution may be of significance. Water drawn from this system has been analysed for sodium, potassium, calcium and magnesium.

Sodium and potassium analysis. These ions were determined by comparison against known concentrations in the Toner–Pitts flame photometer. This sensitive instrument balances a specific lithium ion concentration against the sodium or potassium ion, and the result is found photometrically through specific filters. Either ion may be determined in the presence of the other. Sodium was found to have a value of 534 millimols per litre; and potassium was found to have a value of 18·2 millimols per litre.

Calcium analysis. The calcium was precipitated with an excess of ammonium oxalate, washed, filtered, and this calcium oxalate was dissolved in 1 : 20 sulphuric acid and then titrated to faint pink as end point with 0·01 *N* potassium permanganate, according to the equation:

$$5CaC_2O_4 + 2KMnO_4 + 8H_2SO_4 = 5CaSO_4 + K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O,$$

from which there is a calcium/permanganate ratio of 2·5 : 1; this yields a calcium concentration of 5·8 millimols per litre.

Magnesium analysis. The magnesium was precipitated with dibasic sodium phosphate in the presence of excess ammonium hydroxide to form magnesium ammonium phosphate, and the completeness of precipitation was checked by aliquot addition of more sodium phosphate reagent, a volumetric adaptation of the standard gravimetric technique. The phosphate and magnesium have a direct ratio and the end point found yields a magnesium concentration of 56·2 millimols per litre.

Millimols per Litre Found	
Sodium	534·0
Potassium	18·2
Magnesium	56·2
Calcium	5·8

Dry weight of salts. Taking into account the ratios of sulphates, chlorides and bromides (Lyman and Fleming[1]), conversion of the above values into grams per litre yielded 39·32 gm. per litre, which is found to compare favourably with a value of 39·36 as directly measured from a three-litre sample of water.

Discussion. As will be found by reference to Lyman and Fleming[1], as well as to Thompson and Robinson[2], sodium values hitherto have been by differences after the other ions have been determined. Potassium values are open to the criticism that gravimetric analysis yields a loss factor that is not constant. The constancy of various ion ratios to the chlorinity is not upheld by photometric analysis for potassium, neither is it for the calcium value. Of more significance to this work is that of Page[3], the last recorded analysis of this material, in which there was found by gravimetric means a value of 382·6 millimols of sodium, and a dry weight computable from this of 28·8 gm. per litre. There is good correlation in the percentages of dry weight for magnesium with Page's value 3·4, and this work giving 3·5. There is not good correlation on the calcium values, Page's being 1·2 per cent by weight, and the present work giving just half of that.

Other physical data that may be derived from this analysis are the specific gravity and the chlorinity. When computed on Dittmar's original formula[4], this former is found to be 1·0303, and when computed on the formula offered by Thompson and Robinson[2] the specific gravity is 1·0293. The chlorinity is computed to be 22·06 parts per thousand. The molal lowering is measured at 2·07° C., and computed from Thompson and Robinson to be 2·08° C. These fail to agree with the table for water of this chlorinity in the data of Dittmar, which gives the value of 2·18° C. and a value of 41·2 gm. dry salts per litre. It should be noted that Dittmar's values are for deep-sea surface and depth waters, and the present analysis is for a specific coastal subsurface water.

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Experimentally produced 'Polyagglutinability' (*T*-Transformation of Erythrocytes *in vivo*) in Guinea Pigs infected with Pneumococci

It has been known for many years that treatment of erythrocyte suspensions with certain bacterial culture filtrates (for example, cholera vibrio) alters the erythrocytes so that they become agglutinable by practically all human sera. This phenomenon of 'panagglutinability' has been thoroughly discussed by Friedenreich[1]. It appears to be due to enzymic action on the cell surface, whereby a new antigen or receptor (designated *T*) is revealed, which reacts with a corresponding, very widespread antibody (*T*-antibody). Chu[2] showed that certain pathogenic bacteria, including all types of pneumococcus, could bring about this change. Occasional patients are encountered whose erythrocytes show a phenomenon of polyagglutinability, which appears tc be closely related to the appearance of *T*-antigen. It was therefore of interest to try to produce this state experimentally in animals by means of infection with bacteria that are known to transform erythrocytes *in vitro*.

Guinea pigs have been used for the experiments, as Friedenreich[1], on examination of the erythrocytes of various species, has found those of the guinea pig greatly to resemble human erythrocytes with regard to the *T*-transformation. As pneumococcus Type 19 naturally is pathogenic to guinea pig[3] and capable of *T*-transformation of guinea pig erythrocytes *in vitro*, this type of pneumococcus was chosen for the investigation.

In the first experiment, six guinea pigs uniform in weight, colour and age were used. Cultures from the nose, which often harbours pneumococci, proved the nasal cavity in these guinea pigs to be free from

pneumococci; and it was ascertained that the erythrocytes of these animals did not react beforehand with anti-*T*-sera. Such a reaction was never seen even on examination of a great number of non-inoculated animals. 1 ml. of 5–6 hr. pneumococcus 19 culture was injected subcutaneously into two animals, intraperitoneally into two, while the last two were given about 0·2 ml. of the culture intranasally under anæsthesia.

Blood samples were taken daily from the guinea pigs, and suspensions of washed erythrocytes from these samples were examined in potent anti-*T*-sera.

One animal died shortly after the subcutaneous injection without having shown the *T*-transformation. The other animal infected subcutaneously showed the transformation after 48 hr. Of the animals that were infected intraperitoneally, one showed transformation after a few days, the other no transformation. None of the animals infected intranasally showed transformation.

At the same time as the erythrocytes were examined, the sera of these animals were tested for ability to transform fresh guinea pig corpuscles. To one volume of packed sterile guinea pig erythrocytes two volumes of serum were added, and the mixture was incubated at 37°. At intervals samples of the suspensions were withdrawn, washed and tested for agglutination in anti-*T*-serum. In every instance where the corpuscles of the animals were transformed by the infection, the sera of these animals were found capable of transforming fresh erythrocytes *in vitro*.

In subsequent experiments, transformation of the erythrocytes in the guinea pig has been produced several times in various ways by infection with pneumococci.

A more extensive account of the experiments will be published later.

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Rapidity of Thyroid Reaction to Cold

It has been known for some time that histologically demonstrable activation of the thyroid may be produced in rats[1], guinea pigs and other mammals[2] upon their being subjected to cold for a period of various days. It is also known that this activation takes place by the mediation of the hypophysis[3]. Recent investigations, in which quantitative methods were employed (measures of the average height of the epithelium), led to the conclusion that in order to bring about significant changes the cold should be applied for at least three days[4].

By use of the cytological coefficient, a highly sensitive quantitative index of thyroid activity described elsewhere[5], we have attempted to show more rapid reactions of this type. For this purpose twenty-two guinea pigs, weighing between 150 and 250 gm., were used, of which ten were set aside as controls. The remaining twelve guinea pigs were exposed for a period of half an hour to a temperature of at least 10° C. less than that of the surroundings and thereafter immediately sacrificed. The findings are shown in the accompanying table.

Individual cytological coefficients	
Controls	Exposed to cold
4	21
5	19
3	5
6	8
5	14
3	15
15	22
5	19
4	15
4	16
	13
Means and standard errors	14
5 ± 1·1	15 ± 1·4

The difference between the two groups, 10 ± 1·8, is significant, and justifies the statement that in as short a period as thirty minutes, a decrease of 10° C. in temperature produces an activation of the thyroid in guinea pigs. This activation is inferior to that brought about in the same time interval by 0·001 Junkmann–Schoeller units of thyrotrophin[5].

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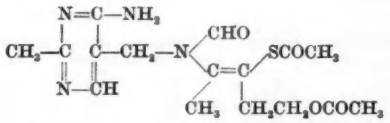
Enzymatic Hydrolysis of the —S—CO— Linkage

During biological and biochemical studies of a new derivative of thiamine, O,S-diacetyl thiamine, synthesized by Matsukawa and Kawasaki[1], it was found that this substance was readily hydrolysed to thiamine and acetic acid by liver extracts[2]. O,S-Diacetyl thiamine:



was found in the earlier work to be almost as efficacious as thiamine by the prevention assay of B_1-deficiency in *Uroloncha domestica*. Although a number of reports have appeared concerning the hydrolysis of ordinary esters by various esterases, no investigation seems to have been carried out on the enzymatic hydrolysis of the —S—CO— linkage except that on the "succinyl and acetyl coenzyme A deacylases" reported by Gergeley *et al.*[3]. We have therefore studied the hydrolysis of lower thioesters, such as methyl thioacetate and ethyl thioacetate, by animal tissue extracts, comparing them with methyl acetate and ethyl acetate. Manometric determination was used for enzyme assays in much of this work.

Table 1 shows that the distribution of thioesterase in extracts of various minced tissues of rats accords with that of the corresponding ordinary esterase, and that methyl and ethyl thioacetates are much more hydrolysable than methyl and ethyl acetates. Unsuccessful attempts were made to separate the methyl thioacetate-hydrolysing activity from ordinary esterase in acetone liver powders. In the case of acetone and ammonium sulphate fractionations of

Table 1. Thioesterase and Ordinary Esterase Activities in Various Tissues of the Rat

Tissue*	Activity (mm.³/10 min.)†			
	Methyl acetate	Methyl thioacetate	Acetyl choline	Acetyl thiocholine‡
Liver	113	679	2	3
Kidney	8	179	—	—
Spleen	1	17	—	—
Heart muscle	0	11	—	—
Brain	0	17	64**	58**
Skeletal muscle	0	7	—	—
Blood (rabbit)	14	34	—	—

* Each tissue was homogenized with 20 vol. of water, and after centrifuging the resulting supernatants were used as enzymes.

** Brain homogenates.

† Final concentration of each substrate: methyl acetate and methyl thioacetate, 0·02 *M*; acetyl choline, 0·0025 *M*; acetyl thiocholine, 0·002 *M*. 37° C.

‡ Acetyl thiocholine was kindly given by Prof. T. Suzuki, Kyoto University.

both enzymatic activities, the distribution of thioesterase was parallel with that of ordinary esterase in every fraction. The most active fraction is obtained between 0·4–0·6 saturation with ammonium sulphate. The enzymatic properties of both esterolytic activities of the liver enzyme were further investigated: effect of *p*S and *p*H, heat-stability, effect of temperature and of some inhibitors. The optimal *p*H for hydrolysis was 8·5 and 9·0 for methyl thioacetate and ethyl acetate respectively (determined by the hydroxamic acid reaction). Both activities were completely inhibited by heating at 60° C. for 10 min. The apparent activation energies of the hydrolysis of methyl acetate and methyl thioacetate were calculated to be 10,400 and 5,800 cal., respectively. Thioesterase was inhibited by 0·0001 *M* atoxyl, just as is the ordinary esterase, while both were resistant to quinine (Table 2).

Table 2. Effect of Atoxyl and Quinine on the Hydrolysis of Methyl Acetate, Methyl Thioacetate and O,S-Diacetyl Thiamine by the Liver Esterase

Inhibitor	Final concentration	Inhibition (per cent)		
		Methyl thioacetate	Ethyl acetate	O,S-Diacetyl thiamine
Atoxyl	0·001 *M*	90	92	65
	0·0001	89	86	49
	0·00002	74	73	—
	0·00001	48	55	33
	0·000001	4	6	8
Quinine	0·005	14	7	—
	0·0025	7	0	—
Methyl acetate	0·1	8	—	47
	0·01	0	—	11

Final concentration of substrate: methyl thioacetate and ethyl acetate, 0·01 *M*; O,S-diacetyl thiamine, 0·008 *M*.

The question arises whether the thioester might be attacked by liver esterase itself or by hydrolase specific for the thioester ('thioesterase'). The preceding results show that both esterolytic activities run parallel in tissue distributions, fractionation and some enzymatic properties. From these results, there was thus no experimental evidence for the existence of an esterase specific for —S—CO— in the liver. Hence, ordinary esterase itself is able to hydrolyse not only the ordinary ester but also the thioester, possibly due to its weak substrate specificity. We have also considered whether the —S—CO— linkage might be phosphorolysed to give an energy-rich phosphate compound, as might be anticipated from the fact that the —S—CO— bond is more unstable. No positive evidence for such a possibility was found from the experiments with liver enzyme and methyl thioacetate.

Details of this work will be published in *J. Biochem. (Japan)*.

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Interaction of the Natural Host and the Canine Hepatitis Virus on the Infectivity of Group *G* Canine Beta Hæmolytic Streptococci

Although infection by hæmolytic streptococci in dogs is presumed from clinical evidence supported to some extent by laboratory findings, the exact etiological relationship of this organism to canine disease cannot be considered as satisfactorily established. Evidence produced by Laughton[1], and the fact that the majority of normal dogs harbour this organism, suggest that, in any event, not all strains are pathogenic to their host. Attempts to reproduce the infection in dogs have been few but, so far, they too have been unsuccessful. In contrast, the primary pathogenicity of the canine hepatitis virus for the dog is well established, and reliable serological tests are available for the diagnosis of infection.

Following up earlier work[2], an investigation was made to determine the effect of the presence of the virus in the tissues in streptococcal infection.

Experiments were conducted on sucking puppies and adult dogs, using the *BECK* strain of hepatitis virus and a Group *G* strain of hæmolytic streptococcus which had been freshly isolated from a case of bilateral pneumonia in a sucking puppy, and which produced rapidly fatal infections when inoculated intraperitoneally into mice and a ferret. The experiments showed that, by prior introduction of the virus, a more severe or fatal infection resulted when the streptococcus was afterwards inoculated than when the streptococcus alone was inoculated into apparently normal dogs. Moreover, those dogs which reacted most severely to the virus showed a correspondingly severe secondary reaction to the streptococcus. On the other hand, doses of 75 millions of the same streptococcus given intraperitoneally to dogs which had received no virus produced only localized infection of the peritoneum followed by resolution, or alternatively no apparent infection.

The details of this interaction and its effects will be published elsewhere; but the overall findings suggest that the presence of the hepatitis virus in the tissues facilitated and aggravated the infection by the streptococcus. It is probable that the more severe reactions were associated with residual tissue damage due to the virus. Under natural conditions it is probable that this interaction finds its greatest expression in canine disease, particularly in the neo-

natal deaths among litters, the dams of which are carriers of both the virus and the streptococcus.

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A Method for the determination of Penicillinase

Henry and Housewright[1] described a manometric method for the assay of penicillinase which was based on the formation of penicilloic acid from penicillin in the presence of this enzyme. It has been found that a convenient way of following this reaction without the use of a manometric apparatus is to estimate penicilloic acid iodometrically. The uptake of iodine by penicilloic acid is not stoichiometric, 6–9 equivalents of iodine being absorbed per mole of penicilloic acid according to conditions[2]. However, with a standardized procedure, reproducible results can be obtained.

Initially, penicillinase contained in a cell-free culture filtrate of *Bacillus subtilis* grown in the presence of penicillin was used, but most of the experiments were done with a penicillinase-producing strain of *Staphylococcus aureus* grown in 'Lemco' broth plus 1 per cent glucose for 24 hr. at 37° C. The cells were centrifuged down, washed once with and then suspended in 0·025 *M* phosphate buffer *p*H 7. Although the product of the reaction between staphylococcal penicillinase and penicillin is unknown, it was assumed that the iodine-absorbing substance formed was penicilloic acid.

0·025 *M* phosphate buffer *p*H 7 was added to the enzyme preparation in boiling-tubes to give a volume of 9 ml. in each, and the tubes were shaken in a water-bath at 37° C. throughout the experiment. After equilibrating for 10 minutes, 1 ml. of a solution of penicillin *G* (15,000 units per ml. in 0·025 *M* phosphate buffer) was added and mixed for a further 2–3 min. 1 ml. amounts were then taken at intervals, pipetted into 5 ml. of 0·005 *N* iodine and each sample titrated immediately with 0·005 *N* thiosulphate, using 0·5 per cent starch as indicator. The uptake of iodine per ml. reaction mixture over a period of 30 min. was taken as a measure of the enzyme activity. A control tube containing penicillin, 1,500 units per ml., without enzyme was included; 1,500 units of penicillin converted to penicilloic acid by alkaline hydrolysis was equivalent to 3·1 ml. of 0·005 *N* iodine under the conditions of these experiments.

During the first few minutes after adding penicillin, the iodine uptake may be irregular, especially with low concentrations of enzyme, but afterwards the rate is constant until about 90 per cent of the penicillin has been destroyed (Fig. 1). Also, the rate of the reaction, within the range of enzyme concentrations employed, was proportional to the amount of enzyme.

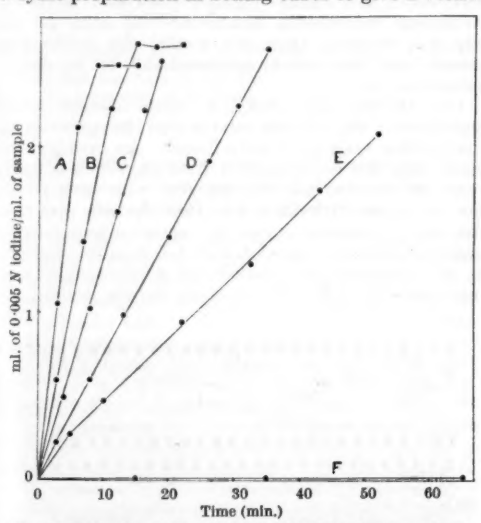

Fig. 1. Rate of penicillin destruction by *Staphylococcus aureus*. The tubes contained cell suspension and 15,000 units of penicillin in a final volume of 10 ml.: (*A*) 5 ml. cell suspension; (*B*) 3 ml. cell suspension; (*C*) 2 ml. cell suspension; (*D*) 1 ml. cell suspension; (*E*) 0·5 ml. cell suspension; (*F*) penicillin 1,500 units/ml. without enzyme. 1 ml. cell suspension = 15·4 mgm. dry weight of cells

I am indebted to Dr. Mary Barber for much helpful advice and to Mr. G. P. Goffi for technical assistance.

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Gonadotrophins in Human Urine

MCARTHUR[1] has claimed that the urine of normally menstruating women contains luteinizing hormone as well as follicle-stimulating hormone. We have confirmed her results and used her method of assay to demonstrate that our system of adsorption chromatography for urinary gonadotrophins[2] has resulted in a separation of an active fraction containing no luteinizing hormone.

Urine was collected from young nurses with regular menstruation, during the luteal phase of the cycle. It was extracted with kaolin[3], and a portion of the crude gonadotrophic extract thus obtained was fractionated by chromatography. We have now compared the biological activity of the first fraction, which we called gonadotrophin *A*, with that of the crude extract.

In preliminary experiments we injected crude extract and gonadotrophin *A* in saline, but we found that these materials were toxic and no luteinizing hormone activity could be detected. We therefore dissolved them in human plasma, since Maddock and

Table 1

Group	No. of animals	Dose	Mean *V* prostate	S.D.	Significance
1 Controls	10	in 0·25 ml. human plasma	6·11	2·0	
2 Crude urine extract	10	16 mgm.	8·73	1·6	(2–1 compared) $P = 0{\cdot}01$–$0{\cdot}001$
3 GA	11	20 mgm. (obtained from about 40 mgm. crude extract)	5·97	2·51	(3–1 compared) $P = 0{\cdot}3$–$0{\cdot}2$

Leach[4] claimed that this resulted in a tenfold increase in sensitivity. We used plasma-injected hypophysectomized rats as controls and we obtained the accompanying results (Table 1).

Gonadotrophin *A* was assayed in intact immature mice by the method of Klinefelter, Albright and Griswold[5]; 10 mgm. caused a sixfold increase in the weight of the uteri.

These results demonstrate that our method of chromatography has removed luteinizing hormone from gonadotrophin *A*. Further results on the gonadotrophin *B* fraction will be published in due course.

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[1] McArthur, Janet W., *Endocrinol.*, **50**, 304 (1952).
[2] Butt, W. R., and Crooke, A. C., Ciba Found. Conf., Coll. on Endocrinology, **5**, 44 (1953).
[3] Dekanski, J., *Brit. J. Exp. Path.*, **30**, 272 (1949).
[4] Maddock, W. O., and Leach, R. B., *J. Lab. Clin. Med.*, **40**, 923 (1952).
[5] Klinefelter, jun., H. F., Albright, F., and Griswold, G. C., *J. Clin. Endocrinol.*, **3**, 529 (1943).

Electrical Method of determining the Sex of Sea Urchins

The sex of sea urchins cannot, with very few exceptions, be ascertained by any external morphological character. A very simple method of distinguishing male and female is to pass an alternating electric current of 10 volts through the animal, and it will at once shed its sperm or eggs. Ordinary 60-cycle alternating current can be used, with the 110-voltage reduced to 10 volts by a household bell transformer or a 'Variac'. Lead electrodes have been found best as they are non-toxic and are easily made from lead tubing (3 mm. bore) sealed over copper wire, or from heavy lead wire. The electrodes are placed at any two points on the shell of the animal which lies, aboral side up, covered with sea water. Almost immediately after the current is passed, the eggs or sperm will exude from each of the five gonopores, the sperm in a thin white thread, and the eggs in a thicker red (in *Arbacia*) thread, later tending to clump. When the current is stopped, the shedding ceases; but it begins again when the current is allowed to pass. In this way, the sex of the animal can be quickly determined, and a few eggs or a little sperm obtained without harming the animal; and the same animal can be used repeatedly. The eggs, if removed at once, fertilize perfectly and develop normally. The method is of great value in places where sea urchins have become scarce.

The rapid response of the sea urchin is due to the presence in the walls of the ovary and testis of a layer of smooth muscle cells which are stimulated by the electric current, causing the walls to contract and force out the eggs or sperm.

A much more elaborate electrical method was described three years ago by Iwata[1] for *Mytilus* and for a Japanese species of sea urchin, *Heliocidaris crassispina*. The simple method described above has also been used successfully on the sand dollar, and several species of annelids.

Sea urchins containing only immature eggs do not respond. In some species a higher voltage may be required.

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[1] Iwata, K. S., *Annot. Zool. Jap.*, **23**, 39 (1950).

The Caval Sphincter in *Phoca vitulina* L.

Examination of dissections and casts of the venous system of twenty-five specimens of the common seal has confirmed, in the main, the findings of previous workers[1]. In addition, the casts revealed the existence of a large vein lying in the spinal canal external to the dura mater. In the lumbar and thoracic regions this extradural vein is single and lies dorsal to the cord; it receives three major tributaries from each renal plexus, and also communicates with almost every segmental vein of the trunk and with the vena azygos. In the cervical region it divides into two smaller veins which lie one on each side of the cord, with numerous anastomosing channels passing between them. These two veins unite deep to the posterior arch of the atlas, and the sinus thus formed communicates with the intracranial sinuses by two veins, each of which passes through the corresponding condylar canal.

It had been desired to investigate the effects of raised external pressure on the animal's circulation, in an attempt to simulate the conditions during diving. Two live pups were satisfactorily and easily anæsthetized by Finer's method[2]. Attempts were made to place the anæsthetized animal on its back into water in a pressure tank. However deep the anæsthesia, even as deep as the stage of respiratory depression, the animal righted itself and rhythmic swimming movements occurred. As soon as the pup was removed from the water, the movements ceased, and the animal appeared still to be deeply anæsthetized.

The thorax and abdomen were opened under anæsthesia; the phrenic nerves and the sphincter on the inferior vena cava were found. An opening was made into the hepatic sinus through which a finger could be inserted into the inferior vena cava within the sphincter. Stimulation of first the left, and then the right, phrenic nerve by square-wave current pulses of 2 m.sec. duration and 4–5 m.amp. intensity at 50 pulses per sec. caused the diaphragm to contract and the sphincter to close tightly around the

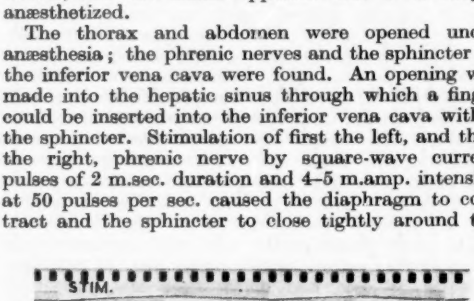

Fig. 1. Contraction of the sphincter on the inferior vena cava of the common seal when (*a*) the right, and (*b*) the left phrenic nerve is stimulated

inserted finger. In a second experiment, a cuffed endotracheal tube was inserted under anæsthesia through an opening in the hepatic sinus until the cuff lay within the sphincter. The cuff was then connected to a capacitance manometer and inflated with air from a syringe through a side tube. Pressure on the cuff caused a deflexion of one beam of a double-beam cathode ray oscillograph; the other beam was used to record stimuli. Fig. 1 shows the result of the experiment. In each instance the lower record is of the contraction of the sphincter and the upper record is of the application of the stimulus. The short vertical lines composing this upper record are the individual stimulating pulses. It can be seen that there is a brief latency (about 0·04 sec.) after the application of the stimulus before the contraction commences. The after-effect, on stopping the stimulus, is longer (about 0·08–0·10 sec.).

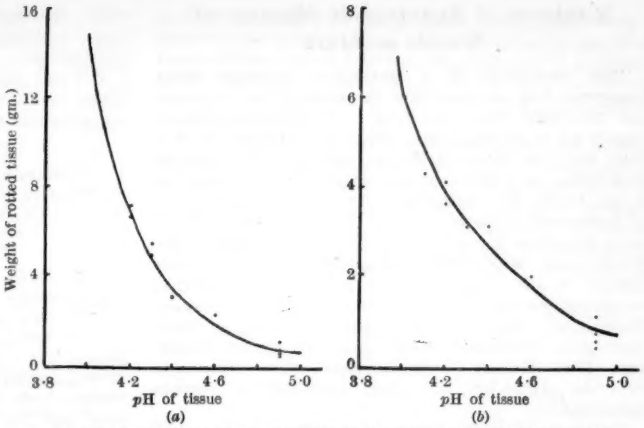

Fig. 1. Correlation between *p*H value of tomato tissue and its susceptibility to attack by (*a*) *Fusarium culmorum* and (*b*) *Fusarium oxysporum*

After making this recording, the branches of the phrenic nerve to the diaphragm were divided, leaving intact the branch to the sphincter; stimulation of this branch caused contraction of the sphincter without contraction of the diaphragm. Stimulation of the central end of the cut right phrenic nerve did not cause contraction of the sphincter.

Further observations on the vascular system of *Phoca vitulina* will be fully described in a later publication.

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[1] Burow, A., *Müller's Arch. Anat., Physiol., wiss. Med.*, 230 (1838). Murie, J., *Trans. Zool. Soc. Lond.*, **8**, 501 (1874). Burne, R. H., *Proc. Zool. Soc. Lond.*, **1**, 385 (1910).
[2] Finer, B., *Anaesthesia* (in the press).

Correlation between *p*H-Value of Tomato Tissue and its Susceptibility to Attack by Two *Fusaria*

The problem of the resistance of plants to fungal or bacterial attack is of great practical importance. If the nature of resistance of a particular plant to a particular pathogen is understood, the plant breeder may be better able to combine the factors for resistance to disease with other desirable characters and so produce a resistant variety of higher quality. This, when it can be done, is usually the most satisfactory method of controlling disease.

The presence in the plant of some substance which inhibits the growth of a particular fungus frequently confers a measure of resistance. A high degree of acidity of the cell sap may confer resistance against organisms intolerant of an acid reaction. The immunity of monocotyledonous plants to the cotton root-rot fungus, *Phymatotrichum omnivorum*, has been attributed by Ezekiel and Fudge[1] to be in part due to the presence of acids in the cell sap.

The following experiment was carried out in an attempt to find out the effect of *p*H-value of tissue of three tomato varieties growing in Egypt, namely, Pritchards, North Dakota and *IAB*, on their susceptibility to attack by two *Fusarium* species, namely, *Fusarium culmorum* (Smith) Saccardo and *Fusarium oxysporum* Schlecht. Green and red fruits of the three tomato varieties were used. Fruits were collected from crops growing under the same field conditions. They were chosen to be nearly of the same age and size. Each fruit was inoculated at the calyx and stylar ends. Twenty replicates were used for each treatment. The method used for fruit inoculation was roughly that given by Granger and Horne[2]. The fruits were incubated at 25° C. for four days. The rotted tissue after the experimental period was then scraped off and weighed. The *p*H-values of tissues collected from the calyx and stylar ends of green and red fruits of each of the three tomato varieties were determined by the B.D.H. capillators with a range of difference of 0·2 unit.

In graphs *a* and *b* the weight of rotted tissue produced by *Fusarium culmorum* and *Fusarium oxysporum* respectively is plotted against the corresponding *p*H-values of the different tissue samples.

The graphs show that although the variations in the *p*H-values of the fresh tissue of the different tomato varieties are so limited, yet there is a definite correlation between the *p*H-value of the tissue and the amount of rot produced by the two *Fusaria* used in this investigation. The susceptibility of tomato tissue to attack seems to decrease with the increase in its *p*H-value.

It thus appears that the *p*H-value of tomato tissue is among the factors governing its susceptibility to attack by *Fusarium culmorum* and *Fusarium oxysporum*.

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[1] Ezekiel, W. N., and Fudge, J. F., *J. Agric. Res.*, **56**, 773 (1938).
[2] Granger, K., and Horne, A. S., *Ann. Bot.*, **38**, 213 (1924).

Virulence of Auxotrophic Mutants of *Erwinia aroideae*

The virulence of a pathogen depends upon numerous factors, including the availability of essential nutrilites from the host. If the host cannot supply all these nutrilites, either in quantity or in a form suitable for assimilation, the pathogen cannot proliferate and produce the characteristic reactions in the host. For example, purine-requiring mutants of *Salmonella typhosa*[1] and of *Klebsiella pneumoniae*[2] were avirulent for mice because the requirement for purine was apparently not satisfied by the host. Garber *et al.*[3] suggested that auxotrophic mutants of pathogens may be useful for purposes of bioassay. Preliminary data from experiments using a plant pathogen, *Erwinia aroideae*, and the potato tuber, var. Red Russet, suggest that this technique may be extended to plant material in certain instances.

Cultures of *E. aroideae* were grown in the *M*-9 synthetic medium[3] 22° C. for 24–48 hr. After 24 hr. in a humid chamber at 22° C., the parental strain, added to the cut surface of a potato tuber, produced a distinctive brown discoloration (and eventually rot). Two auxotrophic mutants of *E. aroideae* were isolated after ultra-violet irradiation: threonine-requiring and tryptophan-requiring. Auxanographic tests indicated that these requirements were apparently specific in that no other amino-acids would satisfy the requirement.

The auxotrophic mutants were grown in a nutrient broth ('Difco') and, throughout the experiments, thoroughly washed prior to use. The threonine-requiring mutant produced the typical discoloration but less markedly than the parental strain. The tryptophan-requiring mutant, however, produced no discoloration. When a few scattered drops of a tryptophan solution were added to the surface of a sliced potato tuber previously inoculated with the tryptophan-requiring mutant, a typical discoloration appeared at the site of each drop. Finally, two mutants which had reverted to prototrophy regained their virulence simultaneously with the loss of the requirement for tryptophan.

These results indicate that the loss of virulence of the tryptophan-requiring mutant is probably correlated with the failure of the mutant population to proliferate, thereby suggesting that tryptophan was not available at the cut surface of the potato tuber. The appearance of the typical discoloration when tryptophan was supplied, and the restoration of virulence in the two strains which had reverted to prototrophy, would indicate this. The maintenance of the virulence of the threonine-requiring mutant suggests that the cut surface of the potato tuber contains the threonine required by this mutant.

Dent *et al.*[4] have reported the presence of threonine and tryptophan in alcohol extracts of potato tuber observed by means of paper partition chromatography. Whether the rapid metabolism of the cut surface of the potato tuber leading to protein synthesis from stored reserves of soluble nitrogen[5] was responsible for depleting the supply of available tryptophan and thereby 'starving' the population of tryptophan-requiring cells is not known as yet. Differences in the kinds or quantities of free amino-acids in different varieties of the potato may also be a factor.

These preliminary data suggest a potential method of bioassay using auxotrophic mutants of pathogens with distinctive pathological reactions in the host to detect the presence or absence of specific substances.

We are indebted to Dr. Peter Ark, Division of Plant Pathology, University of California, for providing material and invaluable suggestions.

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[1] Bacon, G. A., Burrows, T. W., and Yates, Margaret, *Brit. J. Exp. Path.*, **31**, 714 (1950).
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[4] Dent, C. E., Stepka, W., and Steward, F. C., *Nature*, **160**, 682 (1947).
[5] Steward, F. C., and Preston, C., *Plant Physiol.*, **15**, 23 (1940).

Palæozoic Plants from New Zealand

Three small collections of Palæozoic plant fossils have recently been examined and will be reported on more fully in the near future. Plant fossils of Palæozoic age have not previously been found in New Zealand.

The Permian collection was made by B. L. Wood (N.Z. Geological Survey) from the Arthurton Group of Pukerau, Gore District, Southland. The plant fossils are associated with marine fossils indicating a Permian (probably Artinskian) age and consist of well-preserved fragments of leaves. Species identified are *Equisetites* sp., *Cladophlebis roylei* Arb., *Sphenopteris* sp., *S. lobifolia* Morris, F. Neuropteridae, cf. *Linguifolium* sp., *Noeggerathiopsis hislopii* (Bunbury). All the plants identified specifically are known from the Bowen Series coal measures of Queensland[1], which are correlated with the Sakmarian to Tartarian stages of the Permian[2]. The above species are usually associated with glossopterids, which have not been recognized in this flora.

The two older collections come from the Te Anau Group, of Rai Valley and Alfred Stream, Nelson Province, and were found by H. W. Wellman and H. J. Harrington (N.Z. Geological Survey), about 30,000 ft. below the Wairoa Gorge Limestone, which contains marine fossils of lower Permian age[3]. The plant fossils are very fragmentary, consisting of a fern-like pinnule, a Sphenopsid stem and two doubtful sporangia. The presence of the fern-like pinnule suggests that this part of the Te Anau Group is younger than Lower Devonian[4].

I am grateful to Dr. A. B. Walkom, Australian Museum, Sydney, for help with the Southland flora.

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[1] Walkom, A. B., *Queensland Geol. Surv. Pub.*, **270**, 8, 9, 33 (1922).
[2] David, T. W. Edgeworth, "Geology of the Commonwealth of Australia", Table 18 (Arnold, London, 1950).
[3] Wellman, H. W., Proc. 19th Int. Geol. Congr., Symp. Gondwana Ser. (1952). Fletcher, H. O., and Hill, D., *N.Z. Geol. Surv. Pal. Bull.*, **19**, 7, 18 (1952).
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Cerastium arcticum, Lange

In contending that Murbeck and Ostenfeld made the combination *Cerastium edmondstonii* "in contradiction to the rules of botanical nomenclature", and that "therefore the name *C. edmondstonii* is illegitimate" (presumably on the ground of redundancy, as a mere change of status of the type indicated is of itself perfectly legitimate), Miss O. E. Brett[1] is labouring *inter alia* under the common assumption that the European plant is conspecific with those described by Johan Lange principally from Greenland as *C. arcticum*. Having some years ago worked in west Greenland (from parts of which most of Lange's material came) and found there specimens seemingly indistinguishable from those in Herb. Copenhagen determined by him as *C. arcticum*, I ventured to question the validity of this assumption[2]; my feeling that, whatever the status of the European plant, Lange's Greenland material is best treated within the polymorphic complex *C. alpinum* s.l. was supported by the late A. J. Wilmott, and, apparently, by Clapham, Tutin and Warburg[3], who uphold *C. edmondstonii* and give among its synonyms "*C. arcticum* auct., vix Lange". Earlier on, Ostenfeld before his death and also Gelting[4] appear to have come to the conclusion that all the Greenland plants should be referred to *C. alpinum*. The cytological information so far available is not very helpful.

Whether or not Murbeck and Ostenfeld "only redescribed Lange's plant" when they "took the varietal epithet, var. *edmondstonii*, and gave it specific rank" is beside the point, as their new combination was validly published and devolves upon the type described originally from Shetland. If this last is indeed specifically distinct from Lange's 'plant' (which appears to be something of a mixture[5], so that a type specimen would have to be selected if the entity were to be upheld) it should be called *C. edmondstonii*[6]—unless there is serious doubt as to its identity, in which event a new name might have to be given to it (or an old one such as *C. nigrescens* resurrected, though this itself has had a peculiar history[5]). However, further cytogenetic and other investigation (which I cannot myself at present undertake) may indicate that the problem is more complex even than it sounds, with the solution still, as in too many taxonomic instances, dependent upon personal opinion.

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[1] *Nature*, **171**, 527 (1953).
[2] *J. Linn. Soc., Bot.*, **52**, 382 (1943).
[3] "Flora of the British Isles", 299 (Cambridge University Press, 1952).
[4] *Medd. om Grønland*, **101**, No. 2, 36 (1934).
[5] Fernald and Wiegand in *Rhodora*, **22**, 175 (1920).
[6] International Code of Botanical Nomenclature, Utrecht (1952).

To present all the relevant information in order to discuss this point of nomenclature would require more space than is available in these columns. I shall therefore confine myself to stating that Murbeck and Ostenfeld[1] chose deliberately to name this species *C. edmondstonii* rather than *C. arcticum* (which latter name they then regarded as a synonym) because the species was originally described as *C. latifolium* var. *edmondstonii*. This procedure is, of course, contrary to Article 70 of the International Code of Botanical Nomenclature.

I realize that there are certain difficulties in upholding the name *C. arcticum*, Lange. Ultimately, it is a matter of personal opinion whether Lange's description (which in the absence of a type specimen becomes the type) is acceptable. It seems to me that Lange distinguishes between his plant and *C. alpinum* quite clearly; moreover, his description of *C. arcticum* fitted the material which I was using in my cytological investigation.

The situation among these species is, indeed, highly involved. It is possible that further cytogenetic research, upon which I am at present engaged, will reveal that the Shetland plant is a distinct species, and it is also probable that a form of *C. alpinum* ($2n = 72$) is one of the parents, which, by hybridization with another species, produced *C. arcticum* ($2n = 108$).

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[1] *Bot. Notiser*, 246 (1898).

Descartes and Atomism

The Cartesian philosophical concept of the nature of matter has frequently been given indefinite interpretation or assessment in the literature.

The earliest coherent hypothesis postulating matter to be constituted of discrete particles is due to Democritus the Abderite. The predisposing cause of the development of the concept was the desire to make intelligible the perceived qualitative differences in the multitudinous types of known material substances. The particles of Democritus, while being constituted of the same fundamental matter, were considered to possess various shapes and sizes; in addition, they were determined absolutely by being indivisible. Aggregations of various numbers and types of particles explained the empirical phenomenon of variety in macroscopic matter. Particles and void solely constituted material nature for the Greeks.

Greek thought differs only in detail and elaboration from the Daltonian atomic concept; indeed, the influence of the Greek philosophy on Dalton can be traced through the intermediaries Gassendi and Newton. Dalton and Democritus did not differ in fundamental purpose (except in extent of this), namely, to explain the constitution and empirical properties of matter in terms of the properties and arrangements of hypothetical discrete particles. The existence of such a purpose and the associated particle concept necessary to resolve it provide the criterion which defines the true atomist.

The nature and utilization of the particle hypothesis of Descartes was entirely different. Although he built the universe of particles, these were endowed with divisibility[1], and he substituted the void of the ancient atomists by his "matière fort subtile"[2]. The particles of Descartes were therefore in no sense atomic, but only pieces of matter lacking the necessary atomic property of ultimateness. Further, he used his ideas not in any Græco–Daltonian sense but as basis for a mechanical philosophy. It is quite incorrect, therefore, to attribute any development of atomism to Descartes; rather was he a 'deviationist' who, on the basis of a debased 'atomic' theory, produced a theory of mechanical cosmology[3].

J. Grundy

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Sept. 28.

[1] "Les Météores" (Discours premier).
[2] "Principia Philosophiæ", Part iv, sect. 102.
[3] "Principia Philosophiæ", Part iii, sect. 52, 55–59, 63–64.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 11

ROYAL SOCIETY OF EDINBURGH (at 24 George Street, Edinburgh), at 4.30 p.m.—Mr. L. J. F. Brimble: "Science and the Press".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Sir Harold Jeffreys, F.R.S.: "The Present Position in Probability Theory".

Tuesday, January 12

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 2.15 p.m. —Mr. F. Coleman: "The Control of Weeds by Tillage".

INSTITUTE OF FUEL (joint meeting with the COKE OVEN MANAGERS' ASSOCIATION, SOUTHERN SECTION, at the Waldorf Hotel, Aldwych, London, W.C.2), at 5.30 p.m.—Mr. D. T. Barritt and Mr. T. Kennaway: "Some New Carbonization Processes under Development and their Relation to Established Practice".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. F. E. Warner, Mr. A. M. Cook and Mr. D. Train: "Engineering and Microbiological Processes".

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. J. M. Waldram: "Studies in Interior Lighting".

Wednesday, January 13

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (joint meeting with the SOCIETY FOR APPLIED MICROBIOLOGY, at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 2.15 p.m.—Symposium on "Industrial Methods of Sterilization".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. Leslie Knopp: "Stereo-Cinematography".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. T. Neville George: "The pre-Seminulan Main Limestone of the Avonian Series in Breconshire"; Dr. Trevor David Ford: "The Upper Carboniferous Rocks of the Ingleton Coalfield".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. C. W. G. Martin and Mr. D. R. Bailey: "The Stability and Compatibility of Fuel Oil and Diesel Fuel".

Thursday, January 14

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. Jean Brachet (Brussels): "The Role of Ribonucleic Acid in Morphogenesis".*

UNIVERSITY OF LONDON (at the Institute of Laryngology and Otology, Royal National Throat, Nose and Ear Hospital, Grays Inn Road, London, W.C.1), at 5 p.m.—Prof. F. C. Ormerod: "The Use of Antibiotics and Chemotherapy".*

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. A. C. B. Symon: "The Colombo Plan".

BRITISH GLACIOLOGICAL SOCIETY (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.30 p.m.—Mr. Charles Swithinbank: "Glaciological Work of the Norwegian-Swedish-British Antarctic Expedition 1949–52".

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. E. Arnold Carmichael: "Hemispherectomy and Localization of Function". (First of fifteen lectures on "The Scientific Basis of Medicine'.)*

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (at 17 Bloomsbury Square, London, W.C.1). at 7.30 p.m.—Dr. J. Carmichael: "Veterinary Therapeutics and the British Veterinary Codex"; Dr. R. F. Montgomerie: "The Biological Products of the British Veterinary Codex".

BRITISH SOCIOLOGICAL ASSOCIATION (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Prof. M. N. Srinivas: "A Caste Dispute among the Washermen of Mysore".

Friday, January 15

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at King's College, Strand, London, W.C.2), at 4.30 p.m.—Dr. Tudor S. G. Jones: "Paper Chromatography and Electrophoresis"—Discussion and Demonstrations.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Discussion on "Methods of Air and Surface Navigation".

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle upon Tyne), at 6.15 p.m.—Dr. J. M. Robertson: "Metallurgical Aspects of High Temperature Steam and Gas Turbine Plants".

Saturday, January 16

BIOCHEMICAL SOCIETY (in the Department of Chemical Pathology, Postgraduate Medical School of London, Ducane Road, London, W.12), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH ASSISTANTS (2) (qualified, preferably in engineering or industrial psychology, and with experience in industry or in experimentation) IN THE DEPARTMENT OF ENGINEERING PRODUCTION, to assist in experiments on the effect of varying perceptual conditions on output in industrial tasks—The Registrar, The University, Birmingham 15 (January 16).

VICE-PRINCIPAL (with degree in agriculture, and with lecturing and administrative experience) at the Cumberland and Westmorland Farm School, Newton Rigg, near Penrith—The Director of Education, 5 Portland Square, Carlisle (January 16).

LECTURER (Grade II or III) (with a good honours degree and some relevant research or practical experience) IN THE DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Bristol 8 (January 25).

ASSISTANT LECTURER (with qualifications in mechanical engineering) IN ENGINEERING—The Registrar, The University, Manchester 13 (January 30).

CHAIR OF CIVIL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (January 30).

ASSISTANT LECTURER (honours graduate, with postgraduate experience) IN PHYSICS—The Registrar, University College, Keele, Staffs (January 31).

CHAIR OF BOTANY in the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (January 31).

SENIOR LECTURER IN ANIMAL HUSBANDRY at the New England University College, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Armidale, February 1).

REGIUS PROFESSOR OF CHEMISTRY in the University of Glasgow—The Private Secretary, St. Andrew's House, Edinburgh 1 (February 6).

CHAIR OF BOTANY—The Registrar, University College, Singleton Park, Swansea (February 15).

CHAIR OF PHILOSOPHY—The Registrar, The University, Leeds 2 (February 22).

JUNIOR PHYSICAL AND ORGANIC CHEMISTS (with first- or second-class degree in chemistry, and two or three years research experience in physical or organic chemistry) IN THE DEPARTMENT OF SUGAR CHEMISTRY AND TECHNOLOGY, Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (February 27).

LECTURER IN STATISTICS, and a SESSIONAL LECTURER IN MATHEMATICS—The Dean, Faculty of Arts and Science, University of Alberta, Edmonton, Canada (March 1).

PROFESSOR OF PHYSIOLOGY at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, March 1).

ASSISTANT PROFESSOR (with postgraduate training, preferably at the Ph.D. level in fluid mechanics) IN THE DEPARTMENT OF CIVIL ENGINEERING—The University of British Columbia, Vancouver, Canada.

LECTURER OR ASSISTANT PROFESSOR IN THE GEOLOGY DEPARTMENT, to teach invertebrate palæontology and stratigraphy—The Chairman, Department of Geology, Hamilton College, Hamilton, Ontario, Canada.

MATHEMATICIAN (with a good honours degree) with the British Rayon Research Association, to programme work on their electronic digital computer—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

PHYSICAL CHEMIST (with good honours degree, and research experience in a related field) for research on wool fibre and problems related to wool processing, especially detergency, and a RESEARCH CHEMIST, to develop analytical methods for wool research—The Wool Industries Research Association, Torridon, Headingley, Leeds 6.

RESEARCH SCIENTISTS (3) (with first- or good second-class honours degree in physics, chemistry or metallurgy) for work on (*a*) the structure of high melting alloys and (*b*) structural changes produced by martensitic transformations and mechanical deformation of metals—Dr. W. Hume-Rothery, O.B.E., F.R.S., Inorganic Chemistry Laboratory, South Parks Road, Oxford.

SCIENTIFIC OFFICER (with first- or second-class honours degree in naval architecture, or alternatively in physics or mathematics, and with an interest in fluid dynamics) at the National Physical Laboratory, Teddington, for general research in the Ship Division—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting Ref. C.510/53A.

TECHNICIAN (preferably with experience in a physiological laboratory) IN THE DEPARTMENT OF PHARMACOLOGY—The Secretary, University College, Gower Street, London, W.C.1, quoting "Pharmacology/4".

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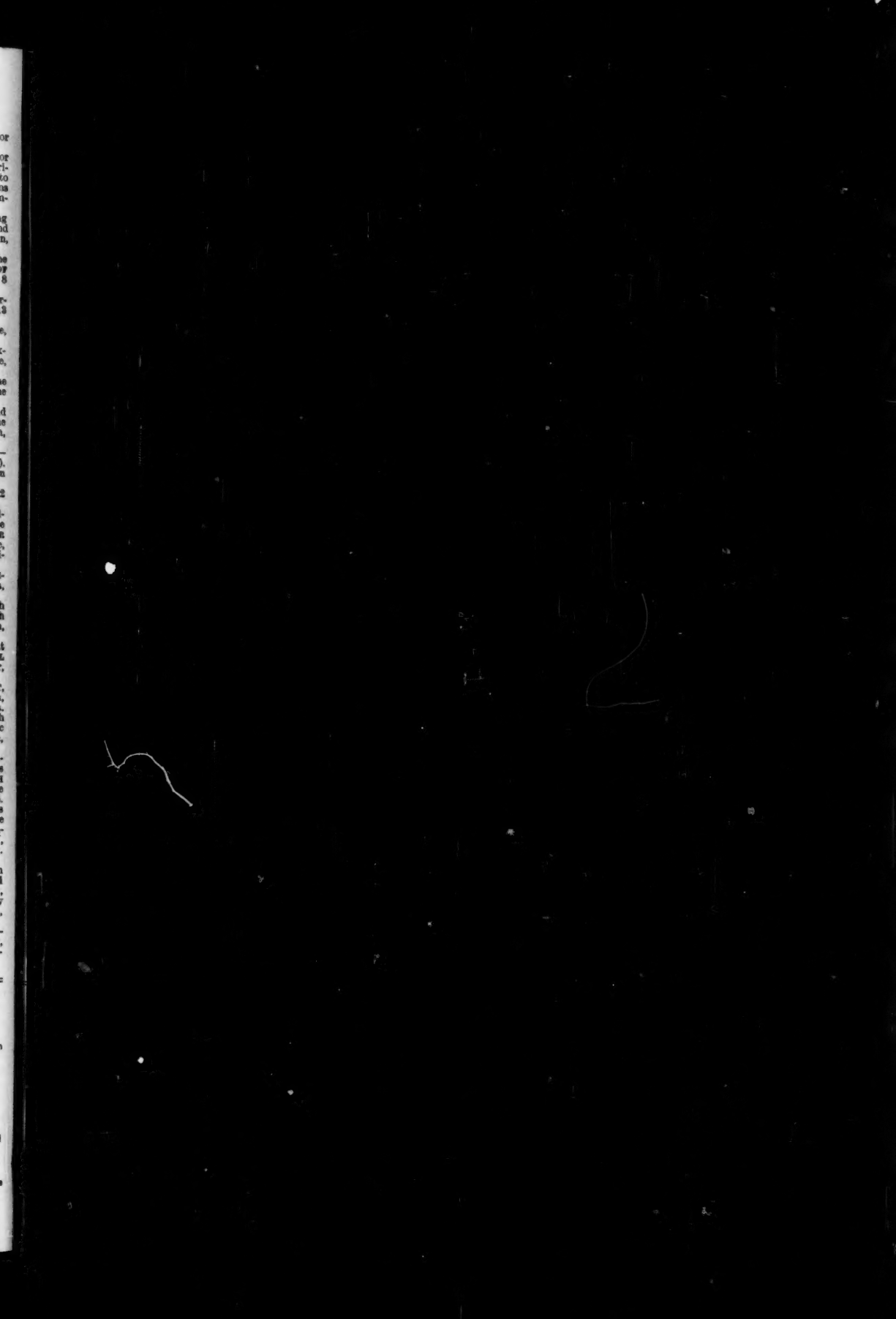
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